Electric Vehicle Leveraged Finance

Opportunities, Challenges, & Solutions

August 2016

VULCAN

IronOak Energy

Why was this research conducted?

Vulcan Philanthropy seeks to catalyze greater electric vehicle (EV) adoption as a complement to the Smart Cities Challenge, its partnership with the U.S. Department of Transportation which will provide a $50M grant to the winning city of Columbus, Ohio, for transportation innovation.

Faster and wider EV market penetration requires a substantial increase in private sector investment, instead of relying on allocations from foundations and the public sector.

IronOak Energy was engaged to assess opportunities, challenges, and financial mechanisms that cities, investors, and other EV market players should consider in their efforts to grow the EV sector and realize its potential financial, environmental, and economic benefits.

Vulcan Inc., based in Seattle, Washington is working to solve some of the biggest global issues. The programs we pursue are inspired by the ideas of our founder, philanthropist Paul G. Allen and tethered to a simple principle; we use data to inform our efforts and seek out opportunities that can make a positive impact—and share what we learn. Vulcan and its philanthropy programs support innovative approaches that can save endangered species, address climate change, improve ocean health, explore new frontiers, research how the human brain works and build sustainable communities. At Vulcan, we strive to answer big questions asked by our founder, and by the world. With a local focus and a global reach, our programs, projects and initiatives bring together industry leaders collaborating across disciplines to discover and develop smart, data-driven solutions and create inspiring experiences that help us tackle some of the world's toughest challenges.

IronOak Energy was created to be a catalyst for clean energy investment, innovation, and intelligence. We provide financial and strategic advisory in the clean energy sector, with a focus on the solar, energy storage, and electric vehicle sectors.

Our core team and “Brain Trust” of collaborators is comprised of PhDs, finance and legal experts, technologists, entrepreneurs, economists, corporate leaders, and professors. IronOak leverages its collective industry and academic experience to help a wide range of high-profile private and public sector clients solve their most pressing strategic challenges in the clean energy sector. IronOak also focuses on the practical business of clean energy development and financing, and has sourced or underwritten over 500 MW of clean energy projects for investment partners.

Presentation Overview

Framing Questions for This Presentation

For Equity Investors and Banks

- What does the data show regarding trends, opportunities, and risks in the EV space?
- What do these data mean for my investment opportunities today and over the next 3-5 years?

For Local Government Leaders and Program Managers

- What are the different categories of investors that could commit more private sector investment to fund EV growth in our city?
- What are their ideal investments, return targets, and risk thresholds?
- Which category of investor is most important to our city in the near term?

Representative Organizations Interviewed and Surveyed

Finance

- **Macquarie Capital**, SVP
- **JP Morgan**, Managing Director
- **BlackRock**, Managing Director
- **American Infrastructure Funds**, Associate
- **Paragon Energy Advisors**, Director
- **TerraForm Global**, Dir. of Global Finance
- **Pattern Energy**, Dir. of Asset Mgt.
- **Apex Clean Energy,** Dir. of New Markets
- **Deutsche Bank**, Managing Director
- **Global Environment Fund**, VP
- **Potomac Investments**, President/CEO
- **Energy Intelligence Partners**, Managing Director
- **Bank of America**, SVP

Government / Policy / NGO

- **NaatBaat**, Executive Director
- **SAFE**, CEO
- **Environmental Law & Policy Center**, Clean Energy Finance Specialist
- **ACORE**, Dir. of Transportation
- **NC local government**, Sustainability Coordinator

Corporate / OEM / Other

- **CBRE**, Global Director
- **XL Hybrids**, CEO
- **Proterra**, Dir. of Business Development
- **PG&E**, Dir. of Strategic Investments and Analysis
- **ChargePoint**, Dir. of Utility Solutions
- **Entergy**, Dir. of New Business Development
- **Nissan**, Dir. of Business Development
- **ARI Fleet Management**, Manager
- **BYD**, Dir. of Government Relations
- **ScottMadden**, Cleantech Specialist
- **Terrapin Bright Green**, Partner
- **Electric Trees**, CEO

Overall Invitations Sent

100+ Semi-Structured Interview

250+ Psychometric Survey

Top 4 Takeaways: For Cities & Non-Private Funders

1. **Remove policy barriers by creating incentives that are predictable and unified**
   - Policy uncertainty and fragmentation create barriers to large-scale investment

2. **Simplify procurement processes and aggregate investment in order to scale**
   - Investors need simplicity and scale in order to dedicate the time and resources required to enter a new market like EVs in a bigger way.

3. **Realize that all investors are not created equal**
   - Build partnerships with investors that cater to their unique criteria for scale, risk, and financial return.

4. **Do not pay full price for EVs or EV chargers**
   - In this report, we identify 16 financial structures to help public sector dollars go further.

Top 4 Takeaways: For Private Market Investors

1. **EVs are not just a cute little niche limited to wealthy environmentalists**
   - The average U.S. car cost $33,500 in 2015. The two most popular EVs cost about $26,000 after federal credits, but before upgrades. (Source: Kelley Blue Book, 2015)
2. **EVs are projected to be first-cost neutral with conventional vehicles by 2022**
   - Now the cost advantage for EVs is in total cost of ownership, driven by roughly 75% lower gasoline-equivalent fuel consumption. Post-2022, the market will grow more quickly. (Source: MIT, 2015)
3. **EVs market growth is not led by Tesla alone**
   - Major automakers such as Ford, GM, Nissan, Mercedes, Volvo, and Volkswagen are making major commitments to expand their EV lines over the next 1-4 years.
4. **Mass market adoption of new tech like EVs can occur faster than we think**
   - For example, refrigerators and cell phones went from 0% to about 80% penetration in 15 years. Will something similar happen for EVs? (Source: New York Times, 2008)

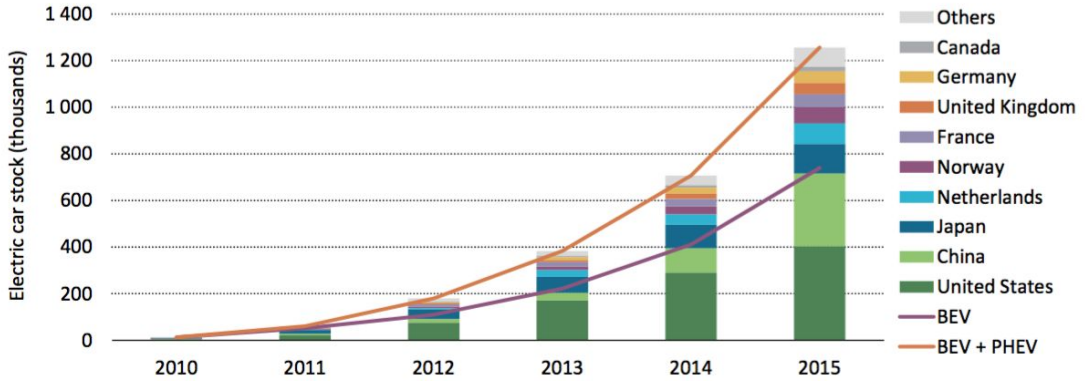
EVs: Where We Are Today – Small but Growing

2015 saw the global number of EVs on the road cross the 1 million threshold, closing at 1.3 million
(Source: International Energy Agency, 2016)

Ambitious targets and policy support have lowered EV costs, extended vehicle range, and reduced consumer barriers in a number of countries

Market shares of EVs rose above 1% in 7 countries in 2015: Norway, Netherlands, Sweden, Denmark, France, China, and UK

Figure 1 • Evolution of the global electric car stock, 2010-15



Note: the EV stock shown here is primarily estimated on the basis of cumulative sales since 2005.

Sources: IEA analysis based on EVI country submissions, complemented by EAFO (2016), IHS Polk (2014), MarkLines (2016), ACEA (2016a), EEA (2015) and IA-HEV (2015).

(Source: International Energy Agency, 2016)

The global EV market is highly concentrated with 80% of EVs located in 5 countries: US, China, Japan, Netherlands, Norway. This highlights current investment locations and also demonstrates the large future growth potential in other countries.

EVs: Where We Are Today – Big Auto, Big Plans

Ford is investing $4.5B in EV solutions, including 13 new EVs for its fleet by 2020 (Source: White House, 2016)

General Motors is launching the 2017 Chevy Bolt with more than 200 miles of all-electric range

Mercedes Benz is releasing 10 plug-in hybrid models by 2017

Nissan has sold more than 95,000 all-electric Leafs in the US

Tesla expects to produce 500,000 electric vehicles in 2018 (Source: Bloomberg, 2016)

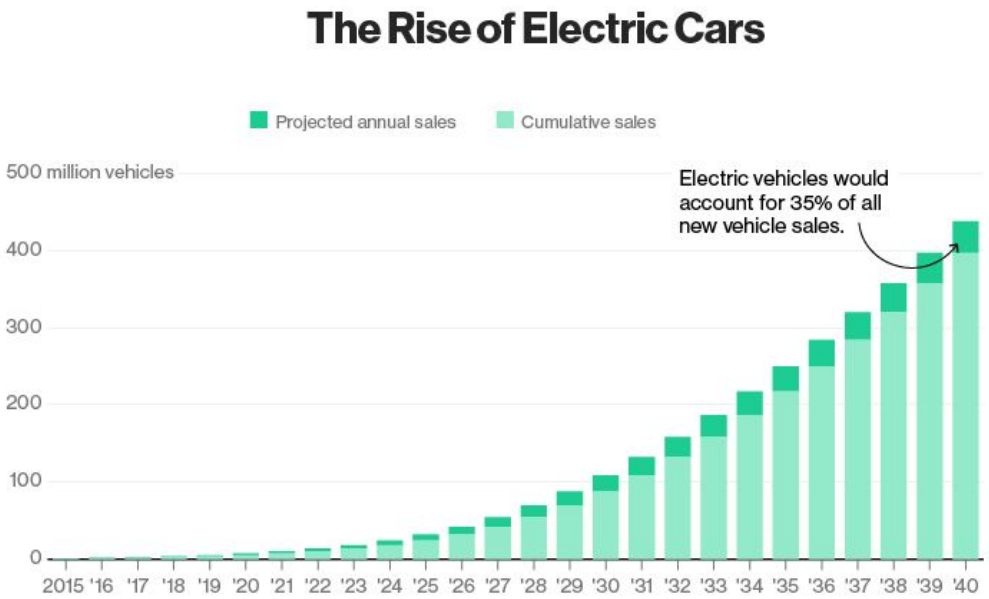
Major EV manufacturers are scaling up production and directly addressing pain points identified by early adopters.

EVs: A Vision of the Future

By 2040, EVs are projected to comprise 35% of the global car fleet, with more than 400 million EVs on the road, putting continuous downward pressure on battery costs through technology development, economies of scale, and manufacturing experience

(Source: Bloomberg NEF, 2016)

EVs are projected to cost the same as conventional cars by 2022. The business case then moves from operational cost savings to include first cost savings, and the market expands more quickly.



(Source: Bloomberg NEF, 2016)

Opportunities: Overview

Cost savings: Lower total cost of ownership (TCO) vs. most internal combustion engine (ICE) cars today; US consumers could save $300B per year if all light duty vehicles switched to EVs (Source: Utility Dive, 2016)

Public policy support and incentives: Limited, confusing, but growing range of federal and state incentives; proven innovation in catalytic solar policy could extend to EVs

Expanding Electric Vehicle Supply Equipment (EVSE) (i.e., EV charging infrastructure): Many utilities and VC-backed private companies are competing to offer solutions to EVSE

Increasing uses: Driver's range anxiety is being alleviated with increased EV range, more charging stations, and dealer access to ICE vehicles for longer trips (e.g., BMW)

Lowering battery technology risk: Perceived risks are greater than actual risks

Growing market: EV market is quickly expanding from small base; 60%-100% annual increase 2012-2016; Early investors can control large future market growth (Source: Centre for Solar Energy and Hydrogen Research (ZSW), 2015; Navigant, 2016)

Opportunities: Market the Lower Total Costs of Ownership

Total Cost of Ownership (TCO) is a critical consumer education topic to overcome sticker shock of paying a premium for an EV vs. ICE vehicles. However, consumers focus on purchase price as the primary criterion "4 out of 5 times." (Source: IronOak Energy Primary Research, 2016)

Factors for calculating TCO:

- Purchase price and sales tax
- Federal and state tax credits and other financial incentives
- Fuel and EVSE costs
- Maintenance expenses
- Resale value -- EVs sometimes depreciate 2x as fast as ICE vehicles (Source: WSJ, 2015)

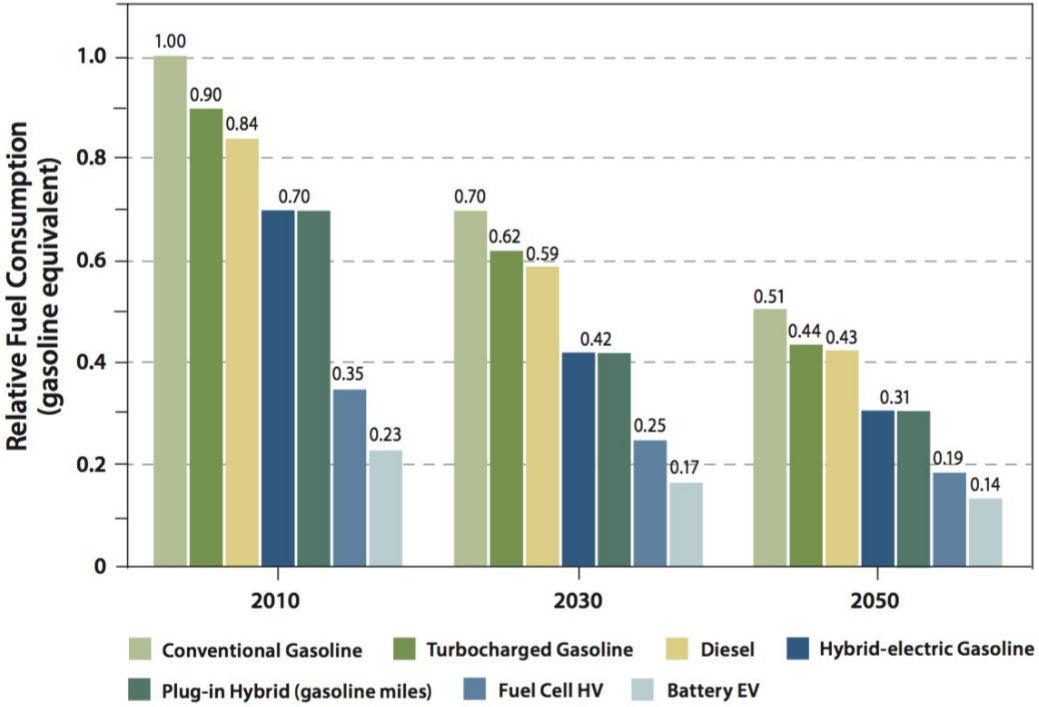
TCO is increasingly relevant for transit planning as public transit entails predictable routes with vehicles experiencing high utilization rates -- transit agencies have long-term planning horizons, which aligns well with EVs' superior TCO

Opportunities: Market the Lower Total Costs of Ownership

EV fuel consumption is substantially lower than other vehicles -- roughly 75% less than ICE cars and 67% less than hybrid-electric gasoline cars

TCO will continue to be a selling point, but primarily in sectors with long-term planning and investment horizons (i.e., not for most consumers)

EV fuel costs 77% less than conventional gasoline for cars in 2015. This is a strong motivator, but only if EV users think long term. Financing that allows savings to accrue monthly will be more desirable than long-term paybacks on an initially higher purchase price.



(Source: MIT, 2015)

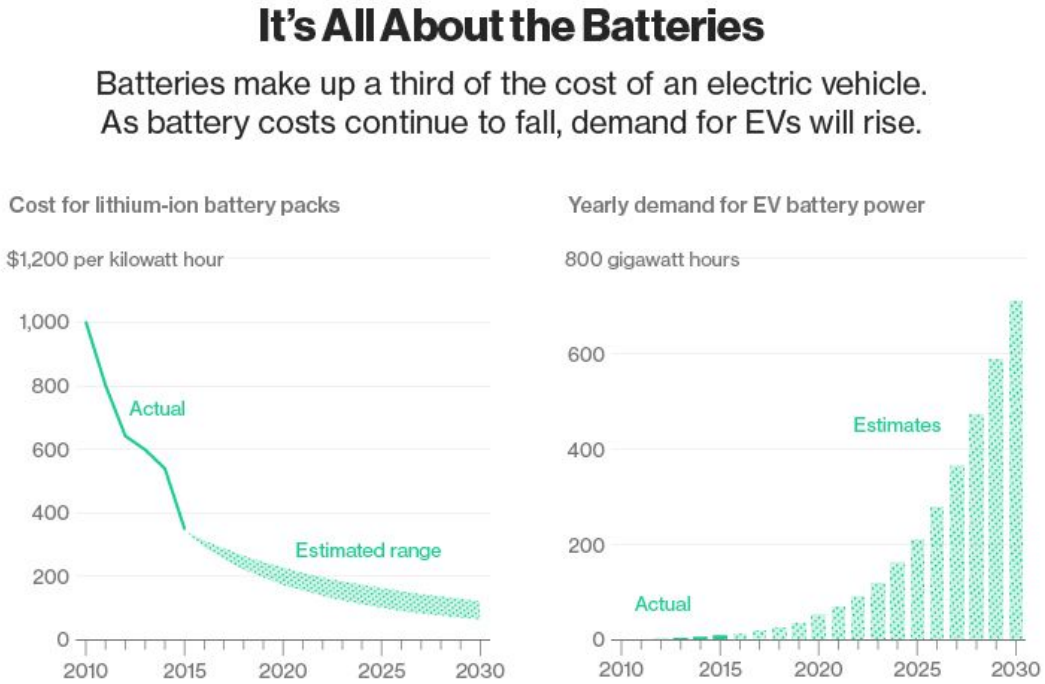
Opportunities: Capitalize on Lower Battery Tech Risks + Costs

Batteries comprise roughly 33% of EV costs (Source: Bloomberg NEF, 2016)

Battery costs have fallen 50%+ in the last few years and technological advances will continue to mainstream demand for EVs (Source: Utility Dive and STEM, 2016)

Over 70 different types of battery chemistries are being tested or deployed today, but lithium is by far the most dominant for the next 3-5 years (Source: IronOak Energy Primary Research, 2016)

The falling price of batteries is a catalyst for and result of EV market growth. Battery tech risks are much lower than market perceptions.



(Source: Bloomberg NEF, 2016)

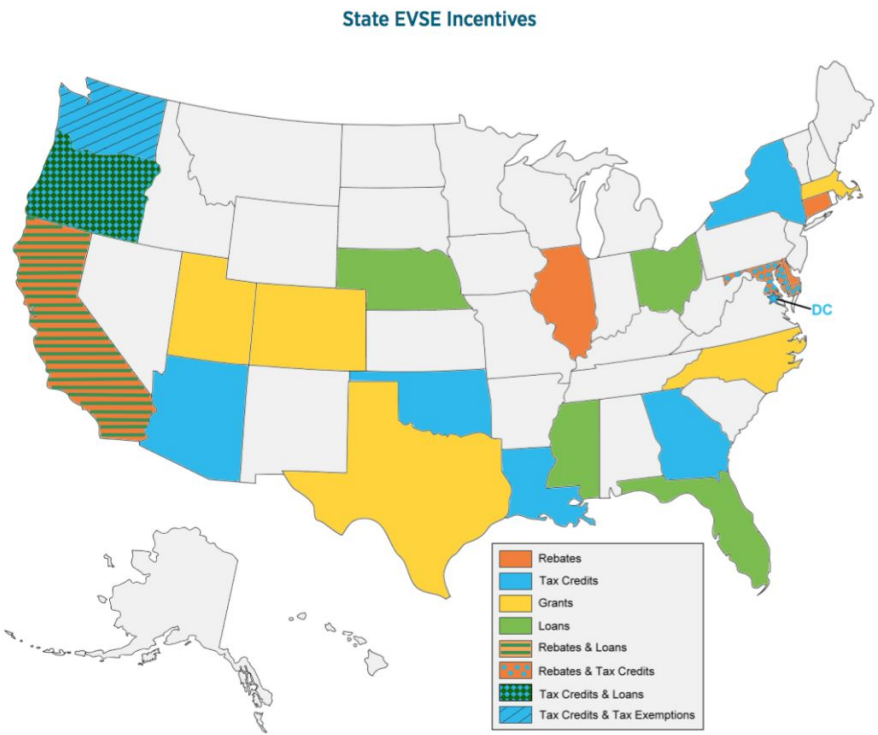
Opportunities: Build on Base of EV Incentives at State Level

Average incentive offered to U.S. EV purchasers is less than $1,000 per vehicle, whereas states like Colorado, Illinois, Louisiana, and California offer $2,000–$6,000 per vehicle in incentives (Source: ICCT, 2014)

Federal tax credit for purchasing EVs is often coupled with diverse state level incentives; there is room for improvement on this patchwork approach (Source: UCLA, 2015)

Some governments are phasing out or removing EV incentives for political or budgetary reasons

State-level incentives are a boost and a hindrance to EV expansion. Investors do not like the policy variation and uncertainty.



(Source: US DOE 2015)

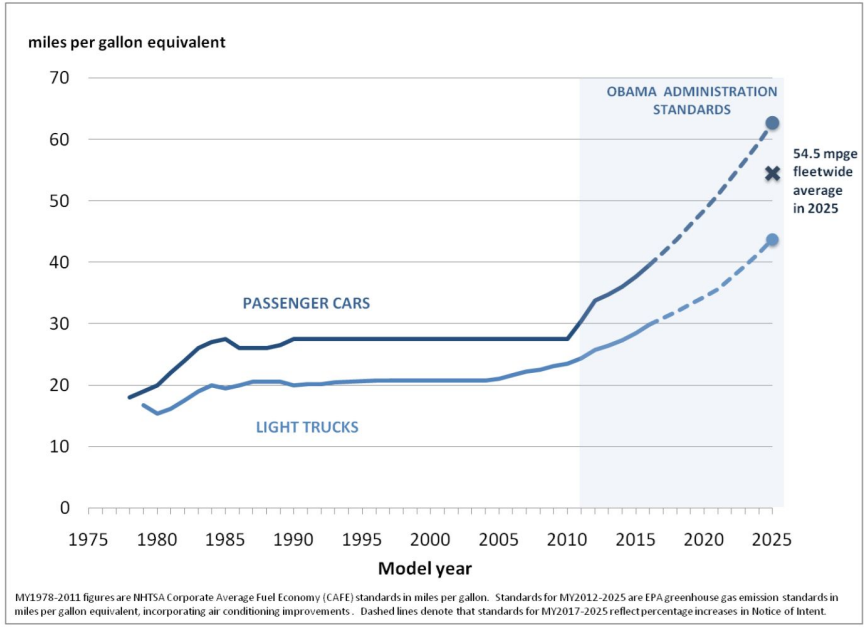
Opportunities: Capitalize on Federal Fuel Efficiency Drivers

Corporate Average Fuel Economy (CAFE) standards will require automakers to raise average fuel efficiency of new cars and trucks to 54.5 miles per gallon by 2025

EVs qualify for credits that are greater than the actual fuel economy they achieve in operation -- each EV in 2017 can be counted as two EVs in terms of fleet fuel economy (Source: RFF, 2013)

Increasing CAFE standards will help drive EV market share compared to less efficient ICE cars. The technological advantage inherent to EVs will increase over time, which will attract forward-looking investors. (Source: UCS, 2016)

CHART 2: LIGHT-DUTY VEHICLE FUEL ECONOMY STANDARDS, 1978-2025



(Source: White House, 2011)

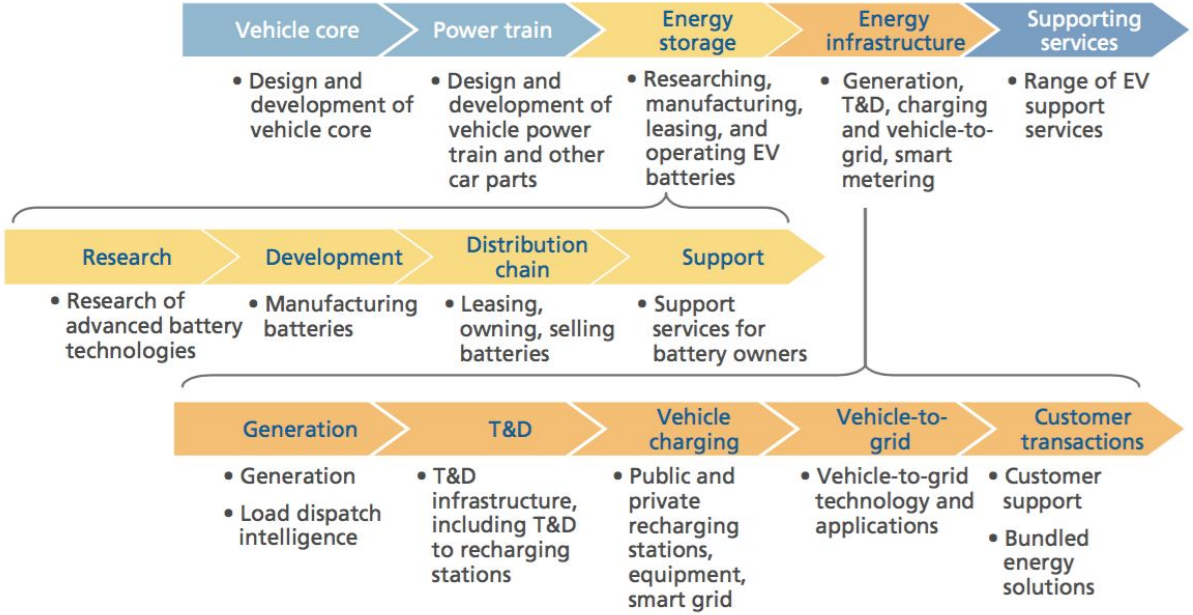
Opportunities: Help Utilities Win as Co-Investors in EVs

Over the next 25 years, EVs could provide 2,700 TWh of additional electricity demand, equal to 11% of 2015 world consumption (Source: Bloomberg NEF, 2016)

If all light duty vehicles in the U.S. switched to EVs, power consumption would rise 25% and utility revenues could rise by $100B (Source: Utility Dive, 2016)

Exhibit 6 **Potential electric vehicle value chain opportunities for utilities**

(Source: Oliver Wyman, 2009)



There are 14 ways for utilities to generate new business in a growing EV sector.
Utilities should be seen as allies, not obstacles.

Opportunities: Help Utilities Win as Co-Investors in EVs

Stakeholders' Varying Motivations by Adding EVSE

	PUBLIC/GOVERNMENT	PUBLIC UTILITY DISTRICTS AND MUNICIPALLY-OWNED UTILITIES	INVESTOR-OWNED ELECTRIC UTILITIES	MERCHANT ELECTRICITY GENERATORS	DEDICATED CHARGING SERVICE PROVIDERS	CHARGING EQUIPMENT MANUFACTURERS	AUTOMAKERS	CHARGING SITE PROPERTY OWNER
Vehicle Fuel Cost Savings	x							
Reduced Environmental and Public Health Costs	x	x						
Economic Development from EV and Charging Station Use	x	x						x
Increased Electricity Use		x	x	x				
More Efficient Use of off-Peak Generation Capacity	x	x	x	x				
Long-Term Prospect of Vehicle-To-Building and Vehicle-To-Grid Benefits	x	x	x	x	x	x	x	x
Greater EV Sales							x	
Sales of EV Charging Equipment						x		
Increased Retail Sales from Offering Charging On-Site								x
Sales of Charging Network Support Services		x	x		x			x

The two most common motivations are for adding EVSE relate to utilities:

(1) hopes for V2B and V2G benefits

(2) ability to better use off-peak resources

(Source: C2ES, 2015)

Challenges: Overview

Cost: EV first-cost price premium vs. lower TCO; Consumers focus on the former

Depreciation: EVs may lose resale value 2x more quickly than ICE vehicles (Source: WSJ, 2015)

Convenience: Driver's range anxiety for longer trips; Concerns with time to charge

Technology Risk: Degradation and longevity concerns; Limited market history of EVs

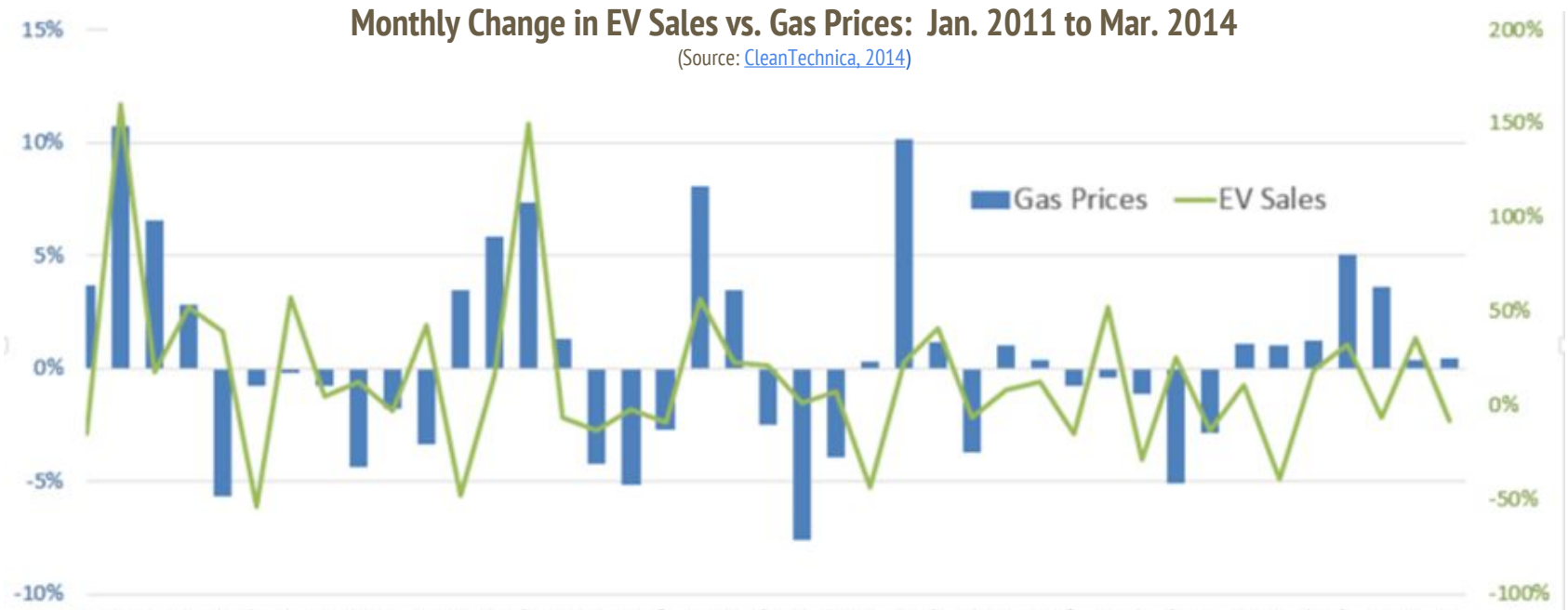
EVSE: "Chicken vs. egg" problem -- Which comes first: EVs or EVSEs?

Carbon Intensity of Electricity: Low GHG power supply -- all grids not created equal

Low Gas Prices: Low and persistent oil and gasoline prices

Small Market: EV market is small relative to other energy / infrastructure asset classes

Challenges: EV Sales Are Affected by Low Oil Prices



There is a correlation between gas prices and EV sales, albeit with a time lag as the market responds. However, EV investments, especially infrastructure, are a long-term, not short-term, play.

Challenges: EV Sales Only Impaired by Low Oil Prices for Now

"Energy is the best sector to invest in right now."

David Rubenstein
Co-Founder, Carlyle Group
Large global private equity with $194B of assets under management

SuperReturn Global Investor Conference
February 2016
Berlin, Germany

Said differently, this billionaire investor wants to "buy low and sell high." He believes that oil prices will go up. This favors greater EV investment over the medium and long term.

Challenges: Barriers Exist for Larger EVSE Networks

"Chicken vs. Egg" (EV vs. EVSE)

Investor skepticism about revenue model of many charging companies given their limited ability to sell electricity in regulated markets, and dependence on capturing indirect value of EVSE

Some utilities are attempting to rate-base EVSE -- creates concerns with competition and non-EV owners subsidizing EV owners

Generating sufficient ROI on charging revenue alone is difficult -- need to capture ancillary benefits, which is a tough sell to pure financial investor

TABLE 14: Challenges from EV Charging Deployment from Stakeholders' Perspective

	PUBLIC/ GOVERNMENT	PUBLIC UTILITY DISTRICTS AND MUNICIPALLY-OWNED UTILITIES	INVESTOR-OWNED ELECTRIC UTILITIES	MERCHANT ELECTRICITY GENERATORS	DEDICATED CHARGING SERVICE PROVIDERS	CHARGING EQUIPMENT MANUFACTURERS	AUTOMAKERS	CHARGING SITE PROPERTY OWNER
Cost to Public of Charging Investment and Subsidies/ Equity Concerns	x	x	x					
High-Power Charging Impacts on Grid Reliability/Need for Distribution Upgrades	x	x	x					
Vehicle-to-Building Technology Could Reduce Demand for Grid Electricity		x	x	x				
Financial Sustainability of Charging Station Investment	x	x	x	x	x			x
Rate of Return of Charging Station Investment				x	x			
Uncertain Impacts of Charging Station Deployment on EV Adoption	x						x	
Lack of Interest in Owning and Operating Charging Infrastructure	x	x	x				x	

The top concerns are: (1) financial feasibility, (2) lack of interest in owning EVSE, (3) charging impacts to the grid, and (4) logic and equity of public sector investments.

(Source: Center for Energy and Climate Solution, 2015)

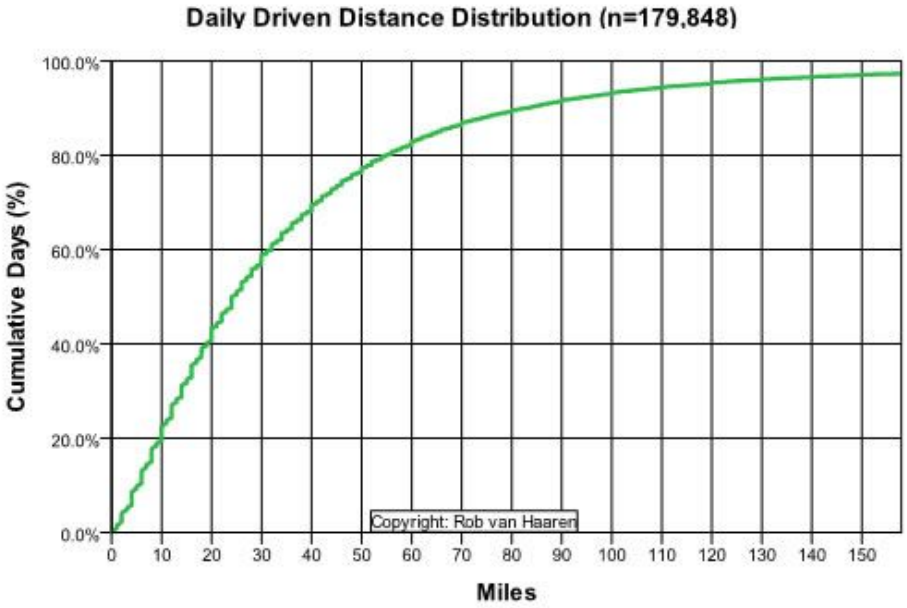
Challenges: Range Anxiety Due to Battery Capacity is Real

Current EVs with >80 miles on full charge: Nissan, Chevy, Kia, BMW, Fiat, Volkswagen, Mercedes, and Tesla (270 miles)
(Source: Autos Cheatsheet, 2015)

Range anxiety may be more of a perceived, instead of actual, risk for the majority of EV use cases -- education is key

Excess battery capacity need not be wasted, but rather monetized via V2G and V2B applications -- business models need further development (Source: IronOak Energy Primary Research, 2016)

80% of American drivers drive <60 miles per day. Range anxiety is not a constraint for most daily commutes.



(Source: CleanTechnica, 2015)

Challenges: Range Anxiety Due to EVSE Infrastructure is Real

Range anxiety remains a large obstacle to the widespread adoption of electric cars

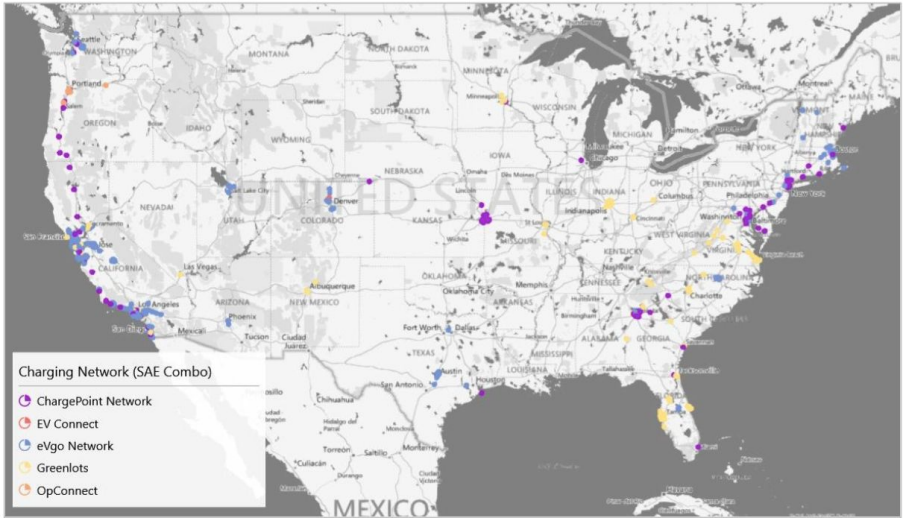
Choosing the dominant connector: one size does not fit all

- CHAdeMO (Many Asian car manufacturers, including Nissan, Kia, and Mitsubishi)
- SAE (Nearly all US and EU-manufactured vehicles, along with Hyundai)
- Supercharger (Tesla)

350 kW fast chargers can charge an EV in less than 10 minutes (Source: Greentech Media, 2016)

EVSE installation (e.g., concrete, trenching, electrical, etc.) can cost just as much as the technology (Source: IronOak Energy Primary Research, 2016)

FIGURE 1: MUCH OF THE UNITED STATES IS INACCESSIBLE TO EV DRIVERS RELYING ON (SAE COMBO) FAST CHARGING



(Source: US DOE 2016)

Many providers are targeting national EVSE networks to address range anxiety, including Tesla, EVgo, and ChargePoint. Investors worry about the lack of interoperability among these networks. They are also excited about controlling them.

Challenges: Market is Too Small. Doesn't Merit Attention (yet).

Large investors are less attracted to EV market due to small market size

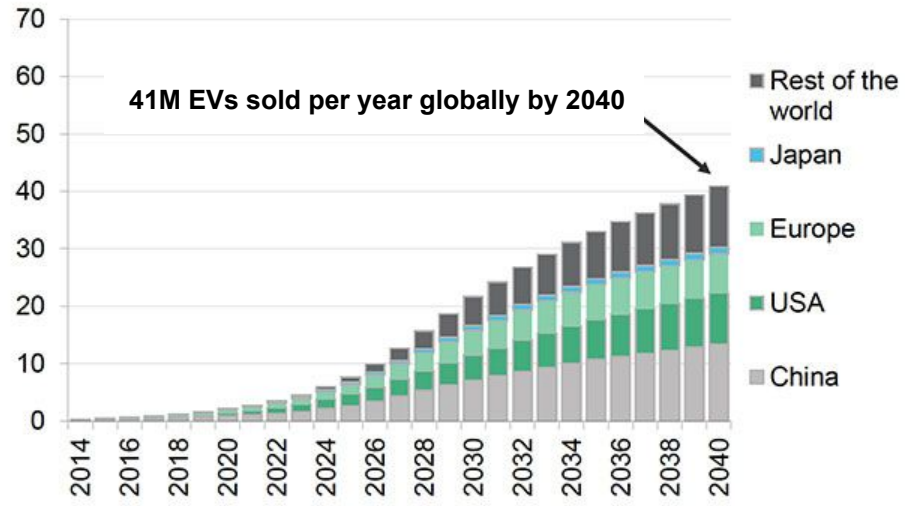
VC market active in investments in early stage companies, but M&A activity very low

Low-carbon infrastructure investors are primarily focused on established generation technology (solar & wind) and increasingly energy storage

For comparison, about $1.5T been invested in solar and wind projects since 2009 (Source: Goldman Sachs, 2015; IronOak Energy, Primary Research, 2016).

For EVs, once technology risks are reduced and costs come down, scale becomes possible.

Global EV Sales Forecast by Geography, 2015-2040



(Source: Bloomberg NEF, 2016)

Challenges: Enabling Factors Vary Geographically

The rate at which EVs and EVSE are being adopted varies dramatically across different geographies

This is only partly explained by incentives -- psychographics and demographics are also key

Investors dislike this fragmented policy approach of varying state and local incentives. This makes it hard for them to achieve large scale investment across many geographies.

Investors also understand that the populations vary geographically, leading to differential rates of EV adoption. This helps them prioritize markets, knowing that education and mass adoption opens up recalcitrant markets later.

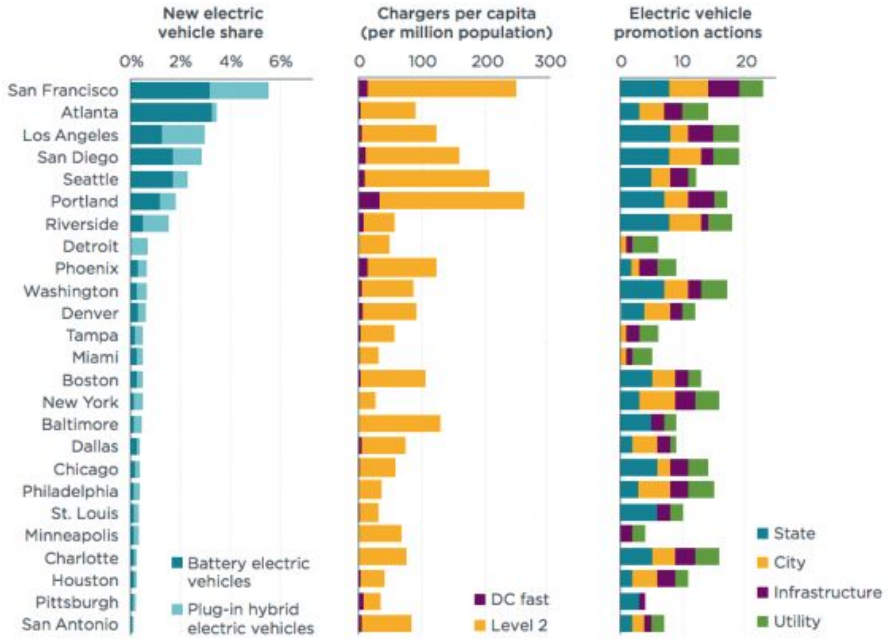


Figure 12. New electric vehicle share, chargers per capita, and electric vehicle promotion actions in the 25 most populous U.S. metropolitan areas in 2014

(Source: EV Obsession, 2015)

Challenges: Disincentives to EV Adoption are Emerging

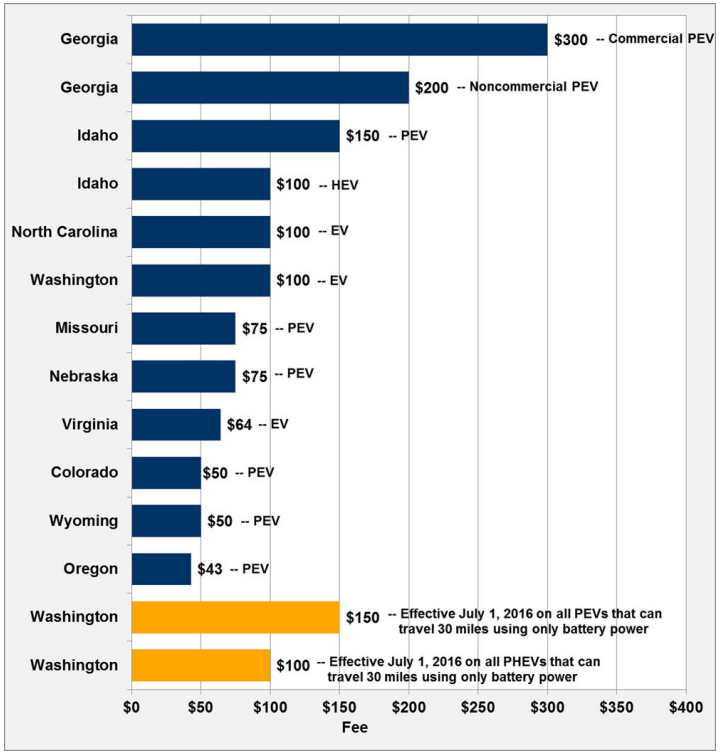
Because EVs do not generate traditional federal fuel taxes, they do not financially contribute to highway maintenance

This has caused many states to rethink how funds are collected to support highway infrastructure, and resulted in the creation of new EV fees in 11 states, with the potential for more to come

The problem of gas tax revenue lost through EVs is negligible compared to the decrease in tax collection that has resulted from the drastic drop in overall fuel consumption

Some states are creating fees that are adding cost barriers to EV adoption. Investors will likely perceive this as a general test of the government's sentiment towards EVs.

States with EV Fees



(Source: US DOE 2015)

Challenges: EV Policies Outdated for V2G/V2B Applications

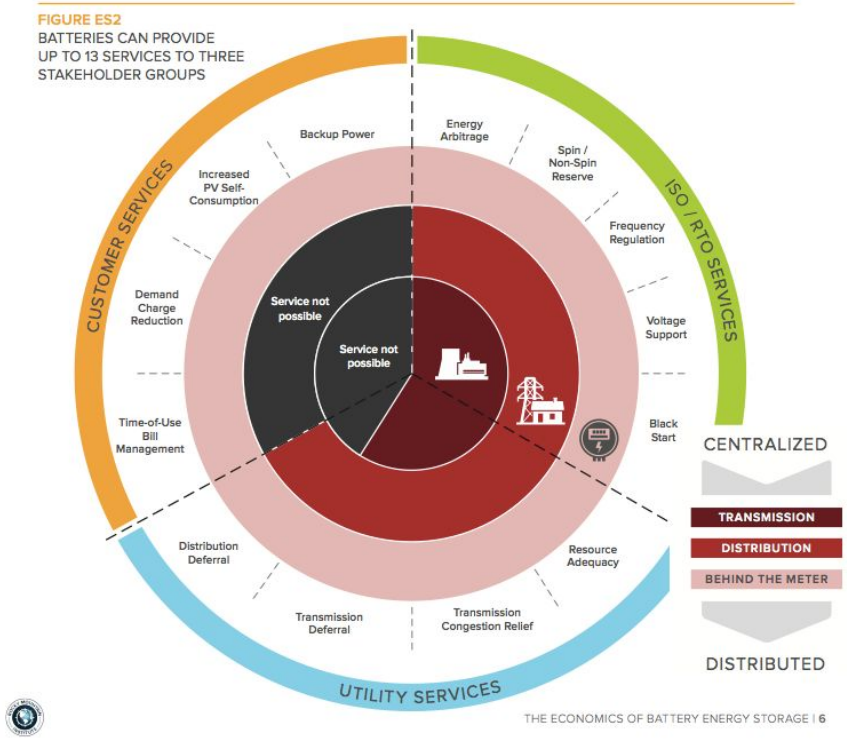
Many investors are waiting to see viable business models for EV batteries used as smart distributed grid storage (vehicle to grid (V2G) or vehicle-to-building (V2B))

If viable V2G/V2B business models emerge, it would unlock multiple revenue streams for EVs, thereby boosting financial returns

Batteries can provide up to 13 different services to the grid, utilities, and customers. EV batteries could provide a portion of these services in V2G/V2B applications.

However, most state and federal policies only allow 1-2 of these values to be monetized.

Financial feasibility of EV investments increases as more revenue streams are monetizable for EV batteries.



(Source: RMI, 2015)

Solutions: Public & Private Investment Strategies

Public Sector

1. Investment tax credits
2. Loan loss reserve funds
3. Interest rate buydowns
4. Low-interest revolving loan funds
5. Loan guarantees
6. Green bonds
7. Carbon credit funds
8. Zero Emissions Vehicle Credits

Private Sector

1. Securitization of EV loans/leases
2. YieldCos
3. Tax credit syndication
4. Tax credit monetization
5. On-bill financing
6. Fleet management company
7. Bundling EV/EVSE investment
8. Power Purchase Agreements

Public Sector Solution #1: Investment Tax Credits

The US federal tax credit for EVSE subsidizes up to $1,000 for consumers and $30,000 for commercial developers (Source: Plug-in America, 2016)

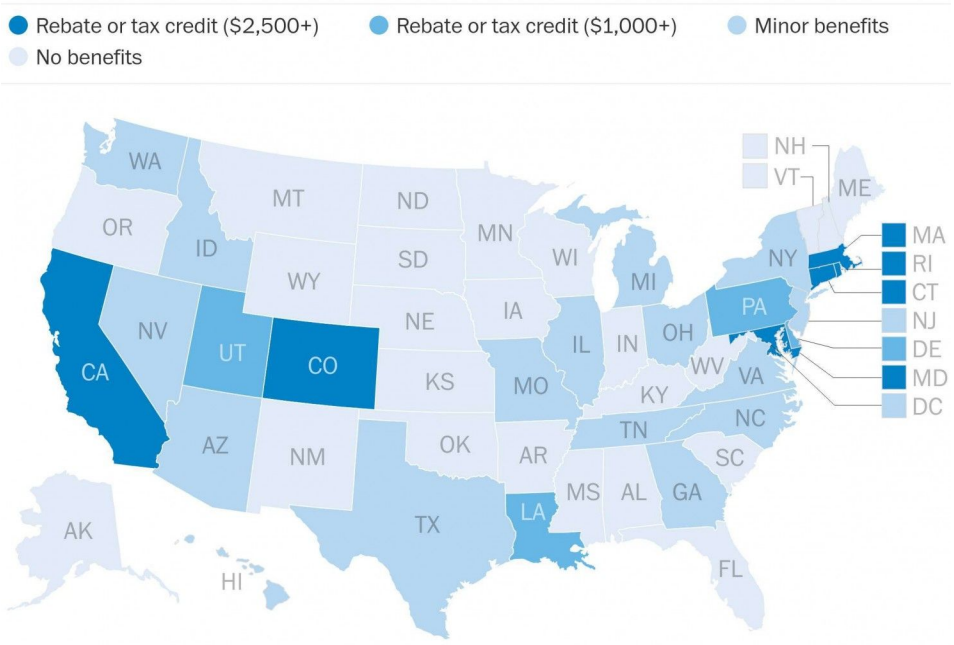
The EVSE tax credit is slated to sunset at the end of 2016

In addition to the federal tax credit of up to $7,500 for EVs, 20 states provide additional incentives (e.g., rebates and tax credits)

The proposed ITC for energy storage (e.g., HR 5350) could support V2G or next generation battery applications

Extending the tax credits for EVSE and EVs will maintain the current incentive structure, which is needed to continue supporting EV adoption.

States with EV Incentives



(Source: US DOE, 2016; Washington Post, 2016)

Public Sector Solution #2: Loan Loss Reserve Fund (LLRF)

The goal of LLRF programs is to help reduce the actual or perceived risks that banks see in making many small loans into a new or poorly understood sector, such as EVs

Often the LLRF repays or “covers” the first 10% of a bank’s losses in a loan portfolio

The LLRF does not cover 100% of the bank’s risks -- they take some risk in order to justify the return on their capital

Benefits include leveraging private funds, reducing interest rates on debt to target projects, and lengthening loan term, all of which can make the project more financially feasible

Example:
If a city government has $1 million available in funds for LLRF, a 5% loss reserve will produce $20 million in capital to lend

Guidance from US DOE on creating a LLRF

These are not radical new programs. They have been used for other energy programs and are supported by DOE. Properly structured, they can catalyze 20x bank debt on top of public sector commitments to mitigate risks to the bank.

Public Sector Solution #3: Interest Rate Buydown

Agreements to subsidize high interest rates that private investors may require as compensation for lending in the less established EV market

Provide either borrower/lender with an upfront sum equal to the present value of the interest payments subsidy over the lifetime of the loan

Similar to grants and rebates in that they entail a transfer of funds with no expectation of repayment

Express purpose is to expend a relatively small amount of public money in order to make private loans more attractive to borrowers (e.g., lower interest rates, longer tenor)

(Source: Center for Energy and Climate Solution, 2014)

Increased private investment in EVSEs can be catalyzed by using public funds for interest rate buydowns to make commercial loans more attractive.

Public Sector Solution #4: Low-interest Revolving Loan Funds

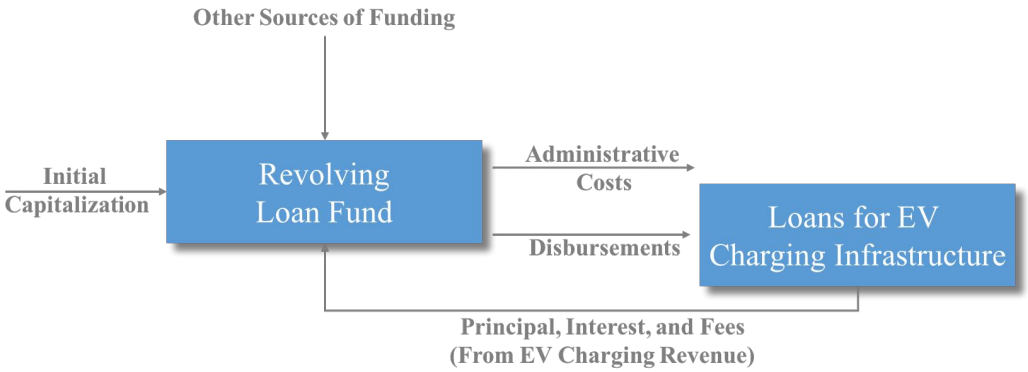
Low-interest revolving loan funds (RLFs) are pools of capital from which loans can be made for EVSE projects

As loans are repaid, the capital is then reloaned for future projects

Assuming that defaults remain low, RLFs can be "evergreen" sources of capital that are recycled over and over again to fund projects well into the future

More than 30 states have established RLF programs for energy efficiency improvements and renewable energy projects

Governments can establish low-interest RLFs to support both public and private sector EVSE development. These models allow for constant replenishment and reallocation of the same initial investment to fund worthy projects.



(Source: US DOE 2016)

Public Sector Solution #5: Loan Guarantee

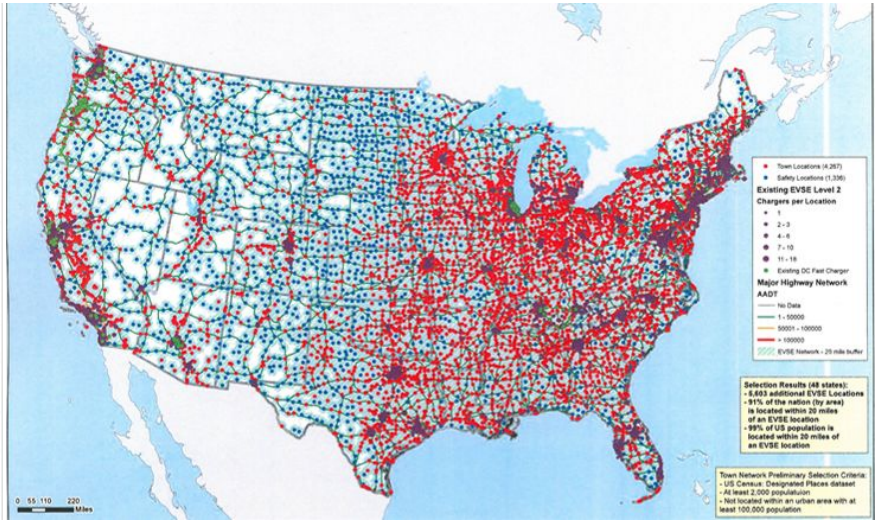
White House $4.5B EVSE Loan Guarantee

- Applies to hardware and software
- Targets DC fast chargers for nationwide EVSE network
- Facilitates procurement of EV fleets by local and state governments at a group negotiated discounted value (Source: White House, 2016)

A nationwide EVSE network by 2020 will require new research into:

- Siting criteria for charging locations
- EVSE comprehensive cost assessment
- Impact of demand charges on customers
- Innovative solutions including a 350kW fast chargers

US DOT's Proposed Nationwide EVSE Network by 2020



By assuming the debt obligation in the event of default, the government is reducing investment risks of wary banks. This leads to more market-rate loans for EVSE deployment.

(Source: US DOT, 2016)

Public Sector Solution #5: Loan Guarantee

50 industry stakeholders added EVSE commitments to White House initiative, including:

- KCP&L installing 10% of its 1,100 EVSE stations in low-income communities
- Portland General Electric spending 10% of their company fleet budget on electrification (Source: CleanTechnica, 2016)
- Avista is installing 272 EVSE connection ports at workplaces and public locations in its Eastern Washington service territory

Dollars invested towards EVSE could create 4x the number of EVs on the road, far outweighing the impact of the federal $7,500 tax credit for EVs directly (Source: National Science Foundation, 2015)

DOE's Workplace Charging Challenge

More EVSEs leads to more EVs on the road. Loan guarantees can be an efficient way to do this. Great success was achieved from the U.S. loan guarantee program for solar years ago. US DOE also sees workplaces as a target for these EVSEs.

(Source: US DOE, 2016)

Public Sector Solution #6: Green Bond Financing

Green bonds are a relatively new financial instrument used to fund low-carbon infrastructure -- investor interest is growing (see details here)

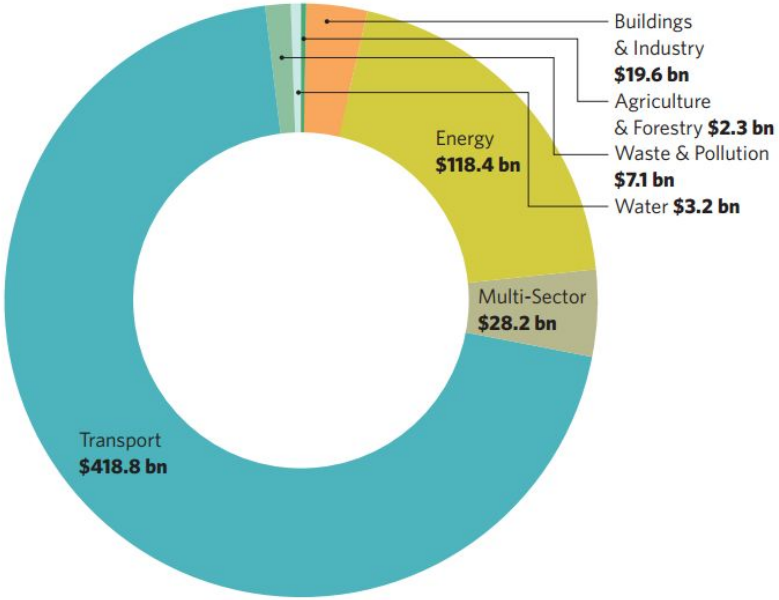
They began in 2007 with $42B allocated last year and a projected $70B this year (Source: Moody's, 2016)

Green bonds represent about 11% of a much broader climate-aligned bond universe of about $600B (Source: Climate Bonds Initiative, 2015)

70% of climate-aligned bonds were allocated to transportation in recent years

Green bonds allow public issuers to access low cost capital for public infrastructure projects. Investor demand is often 2x supply for green bonds.

Transport continues to be the dominant theme in the $597.7bn climate aligned universe



(Source: Climate Bond Initiative, 2015)

Public Sector Solution #7: Carbon Credit Funds

Cap-and-trade policies are designed to regulate emissions, and can create a market in which carbon credits are generated and traded, as in California with AB 32

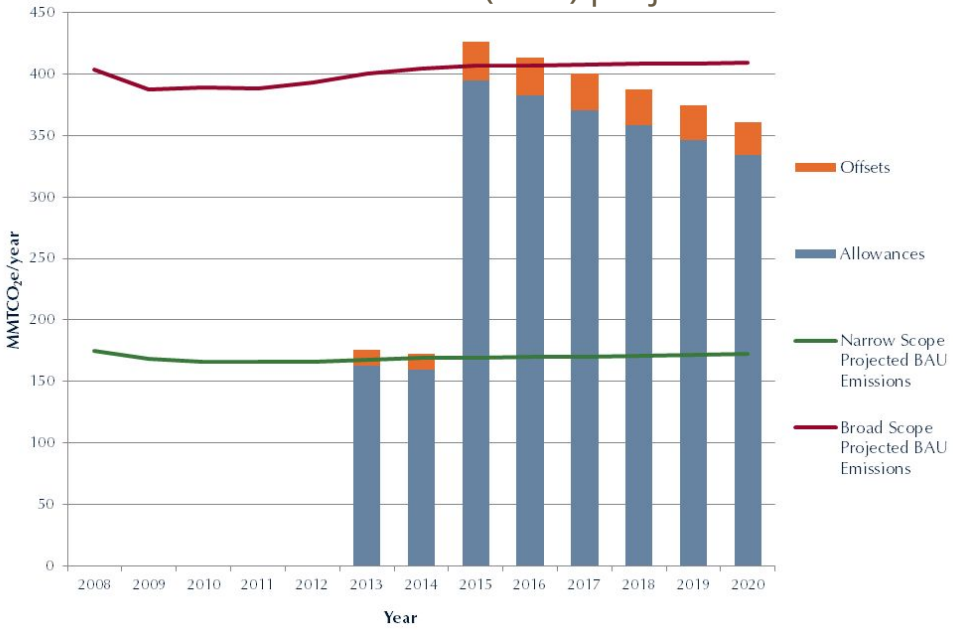
Under this regulatory structure, large polluters buy carbon credits generated by businesses with surplus allowances

Carbon credits are generated from a wide range of emissions-reducing activities

Collected carbon credit funds from the cap-and-trade auctions can go toward other emission-reducing endeavors, including rebates for EVs ($325M in CA) (Source: CARB, 2016)

Carbon credit funds can be generated through cap-and-trade or other revenue-generating programs to help fund EV rebates and other incentives.

California's GHG emission cap and business-as-usual (BAU) projections



(Source: Center for Climate and Energy Solutions, 2016)

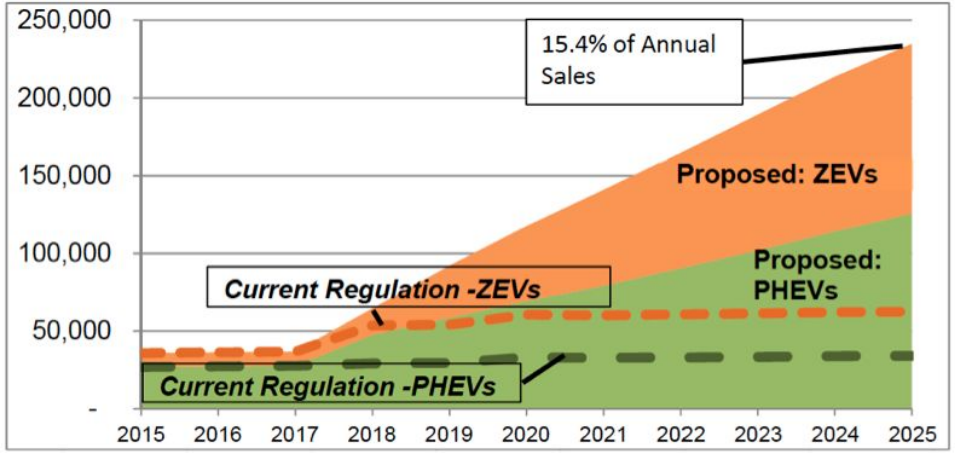
Public Sector Solution #8: Zero Emissions Vehicle Credits

California's Zero Emissions Vehicle (ZEV) Program mandates that car sales are comprised of 14% ZEVs (Source: CARB, 2016)

- 2015 -- 61,915 ZEVs were sold
- 2018 -- 75,000 ZEVs must be sold to meet the regulation, an increase of 21%
- 2025 -- 15% of CA vehicle sales must be ZEVs, an estimated 265,000 per year, an increase of 250% in the next decade (Source: ZEV Facts, 2016)

Companies that exceed this target can generate ZEV credits, which can be sold to other manufacturers who have failed to meet the set standard

ZEV credit programs create an incentive for car manufacturers to sell more ZEV cars, and a revenue stream from the sell of ZEV credits to manufacturers that fail to meet the standard.



(Source: GreenTech Media, 2016)

Public Sector Financing Solutions	Pros	Cons
Investment Tax Credits	Creates simple financial incentives for EVs and EVSE to offset initial capital costs	Requires EV purchasers or EVSE developers to have sufficient tax liability to monetize the tax credit -- necessitates syndication or monetization strategies
Loan Loss Reserve Funds	Reduces the risks that banks perceive in making many small loans into the EV sector by covering the first 10% of a bank's losses in a loan portfolio	Does not cover 100% of the bank's risks, so they still need to take some risk in order to justify the return on their capital
Interest Rate Buydowns	Subsidizes high interest rates that investors require as compensation for lending in uncertain markets	Uses public money in order to make private loans marginally more attractive to borrowers
Low-Interest Revolving Loan Funds	Provides "evergreen" sources of capital that are recycled to fund EVSE projects on a continual basis	Depends on revenues generated from the EVSE project -- tends to fund only very low risk projects
Loan Guarantee	Assumes the debt obligation in the event of default, and addresses a huge pain point for the EV industry	Requires application to a competitive federal program offered to a wide range of energy projects
Green Bond Financing	Gives access to low-cost capital for clean infrastructure projects/investments for both public and private sector	Requires high transaction costs associated with issuing a large bond
Carbon Credit Funds	Provides a mechanism to generate large quantities of incentive funding from emitters	Requires the creation of a cap-and-trade or other carbon regulatory structure in order to create the market structure for carbon credits
Zero Emissions Vehicles Credits	Incentivizes car manufacturers to design and sell more EVs -- creates a revenue stream for leading edge EV car manufacturers	Creates a complex trading market for ZEV credits between car manufacturers, which has resulted in backlash from the penalized companies

Public Sector Financing Solutions	Angels	Venture Capital	Private Equity	Infra. Investors	Banks	Retail Investors	Corporate Finance	EV Consumer	EV Car Co.	EVSE Developer	Utilities
Investment Tax Credits		X	X	X	X		X	X	X	X	
Loan Loss Reserve Funds				X	X						
Interest Rate Buydowns				X	X					X	X
Low-Interest Revolving Loan Funds				X	X					X	X
Loan Guarantee		X	X	X	X		X		X	X	
Green Bond Financing			X	X	X		X				X
Carbon Credit Funds								X		X	
Zero Emissions Vehicles Credits							X		X		

Public Sector Financing Solutions	City	State	Federal
Investment Tax Credits		X	X
Loan Loss Reserve Funds	X	X	X
Interest Rate Buydowns	X	X	X
Low-Interest Revolving Loan Funds	X	X	X
Loan Guarantee	X	X	X
Green Bond Financing	X	X	X
Carbon Credit Funds		X	
Zero Emissions Vehicles Credits		X	

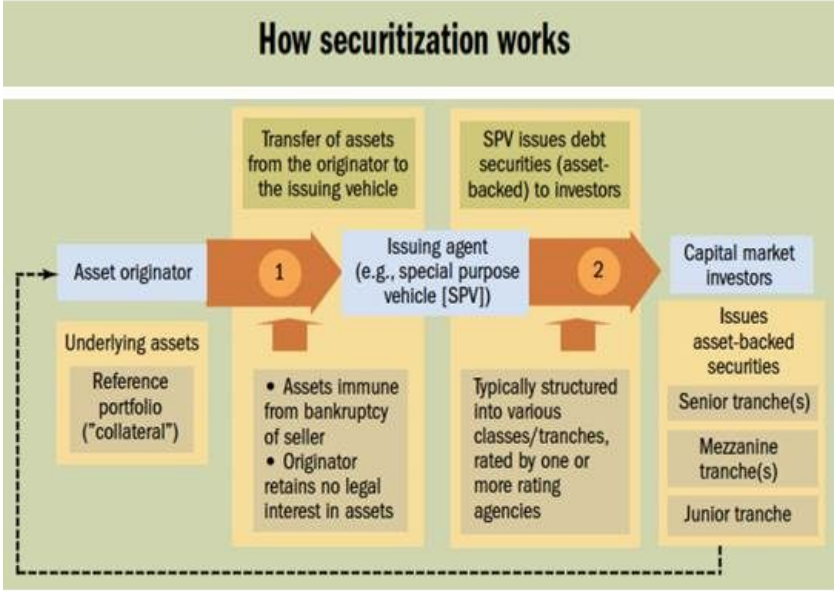
Private Sector Solution #1: Securitization of EV Loans/Leases

Securitization of EV loans and leases presents an opportunity to access larger pools of capital -- already being done as car companies originate loans/leases and banks create securitize them (e.g., Wells Fargo, US Bank)

Larger banks and institutional investors are interested in EV lease/loan securitization once the scale supports the transaction costs

Lease penetration in the EV market is 75% compared to 28% across all cars (Source: Manheim, 2016)

But, investment banks with experience in leasing to cities still consider e-bus/EV market too small



(Source: NREL, 2013)

Securitization allows larger banks and institutional investors to invest in asset-backed securities comprised of bundles of EV loans or leases, which provides capital to the originator.

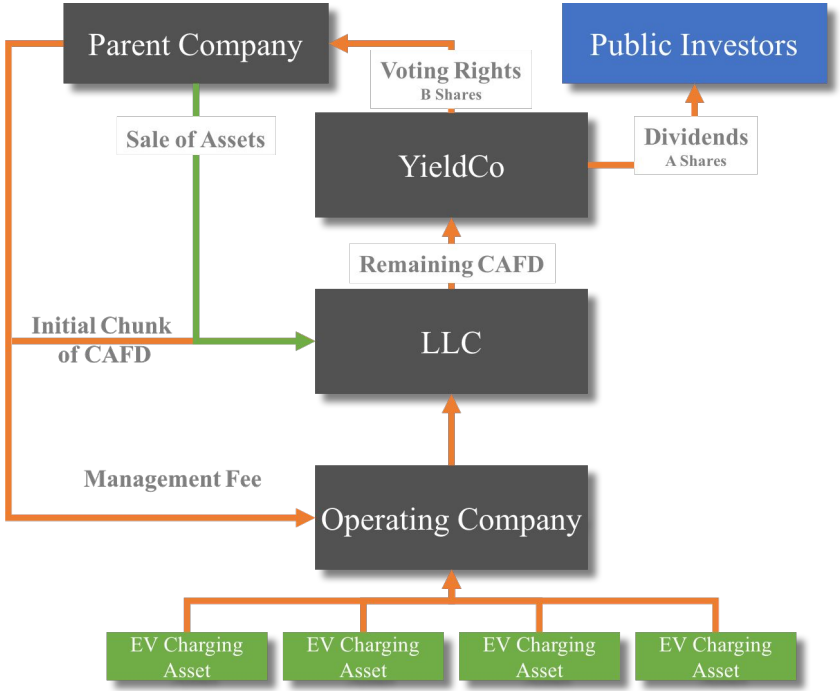
Private Sector Solution #2: YieldCo

YieldCos -- similar to a Master Limited Partnership (MLP) -- are publicly traded corporations that provide stable and growing distributions for investors from operating assets that generate a predictable stream of cash flow

Possible future applications to EVSE -- YieldCos can be created from assets that would not generate the qualifying income required for passthrough treatment under the current tax law

Currently yieldco model for solar is flawed, but experts suggest it will be remade (Source: Utility Dive, 2016)

Yieldco structures could be employed to help finance EVSE if a stable, long-term cash flow can be established.



CAFD = Cash Available For Distribution

(Source: NREL, 2014)

Private Sector Solution #3: Tax Credit Syndication

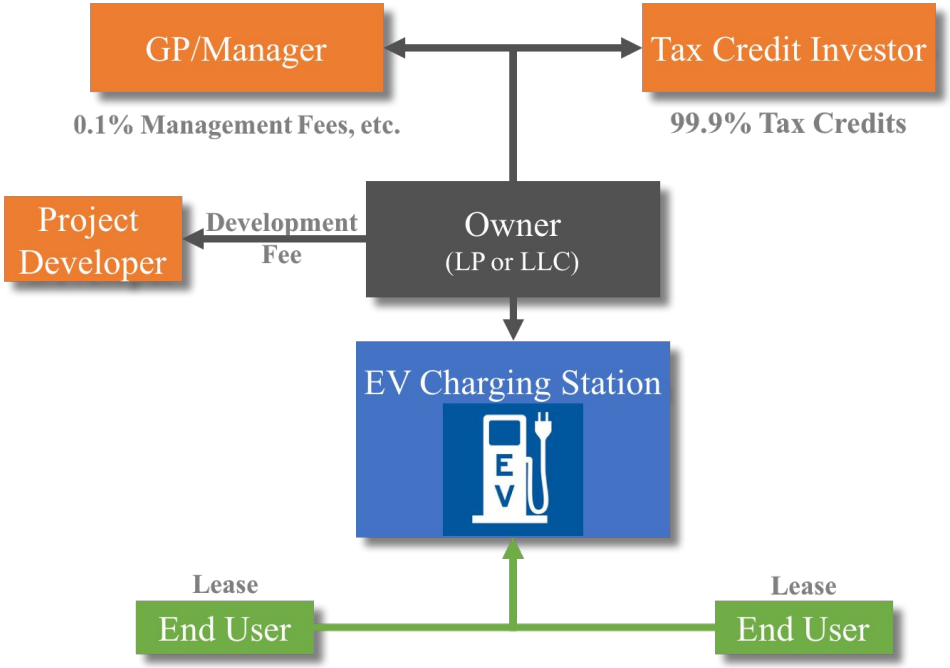
Tax credits are an effective financial incentive for developing EVSE

The Commercial Federal Tax Credit provides a tax credit valued at 30% of qualifying project costs (up to $30,000) (Source: ChargePoint, 2016)

To monetize the tax credit, the developer needs a tax liability in excess of the value of the credit, which can be a constraint

Syndication allows third-party investors to become project "owners" as limited partners and developer to monetizes value of tax credits

Tax credit syndication allows project developers to access key project finance through monetizing future tax credits, which they can not utilize, via third-party entities with substantial tax liability.



(Source: Nixon Peabody, 2009)

Private Sector Solution #4: Tax Credit Monetization

Tax credits are an effective financial incentive for EV purchases, but car buyers have to wait until filing taxes to claim the credit and moreover need a large tax liability

EV buyers can claim up to $7,500 in federal tax credits (Source: US DOE, 2016)

States provide additional tax credits of up to $5,000 (Colorado) (Source: Plug In America, 2016)

Colorado's HB 16-1332 creates a tax credit monetization program that allows the buyer to claim the credit to the financial lender, who in turn would offer the discount at the time of purchase

Tax credit monetization allows car buyers to pass on the tax credit to the lender so they can take full advantage of the credit at the point of purchase.

States with EV Incentives

(Source: Plug In America, 2016)

Private Sector Solution #5: On-Bill Financing

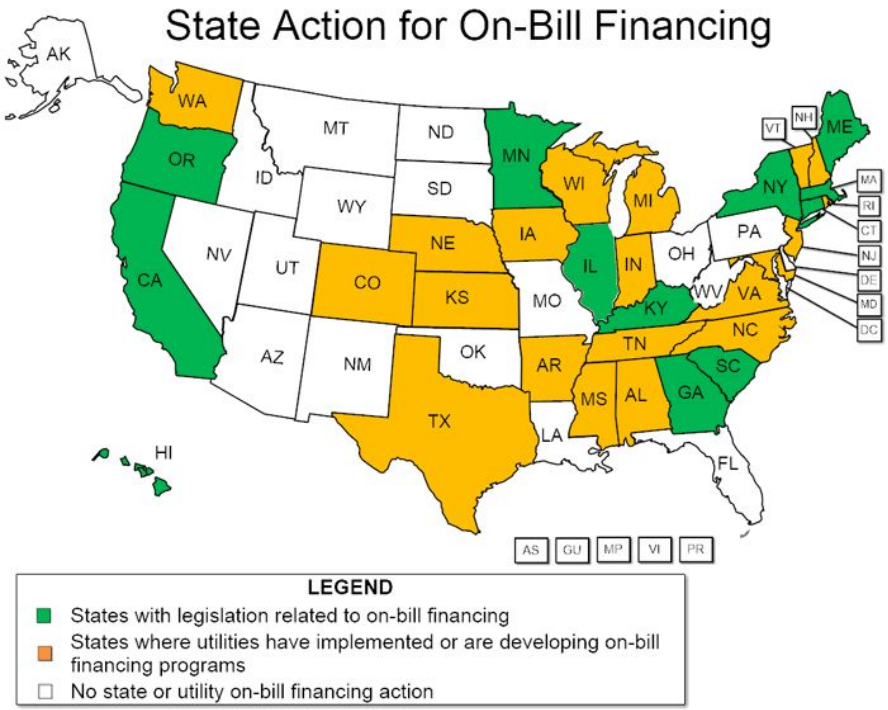
Housing developers are interested in spreading the cost of EVSE infrastructure across tenants' monthly utility bills

On-Bill Financing (OBF) has been used to finance a variety of upgrades including exterior security lighting, energy efficiency, and solar energy

OBF provides a secure revenue stream because failure to pay can be tied to disconnection (Source: US DOE 2016)

Creditworthiness can be determined by reviewing past bill repayment history

Utilities benefit from increased EV electricity demand, and can also recoup the upfront EVSE development expenses via on-bill financing strategies.



(Source: NCSL, 2015)

Private Sector Solution #6: Fleet Management Company

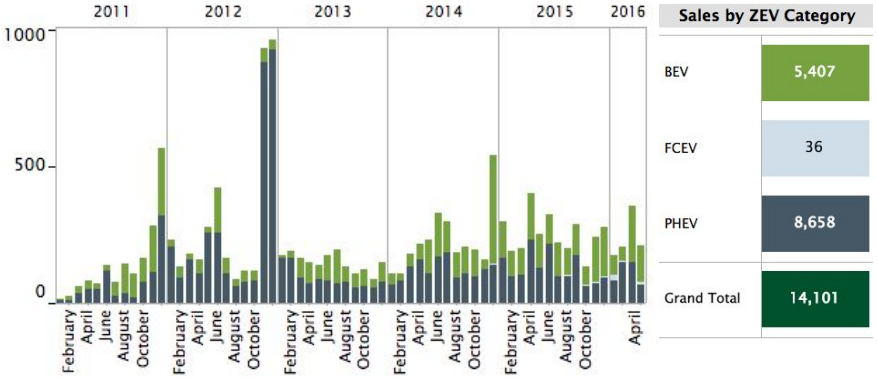
Large fleet management companies (e.g., ARI), which control millions of vehicles, are still hesitant to invest heavily in EVs
(Source: IronOak Energy, Primary Research, 2016)

Fleet managers are attracted to low refueling costs and predictable fuel prices -- long-term hedge strategies, similar to corporate and government interest in solar PPAs

Consumer demand is creating EV fleet inventory rather than TCO factors
(Source: IronOak Energy, Primary Research, 2016)

Fleet operators are still concerned about range anxiety and resale value

Government and Private Fleet EV Sales



(Source: ZEV Facts, 2016)

Fleet management companies could be attracted to the economics of EVs, and are in the position to make long-term investments in EVs at scale. This could support EV adoption by smaller entities.

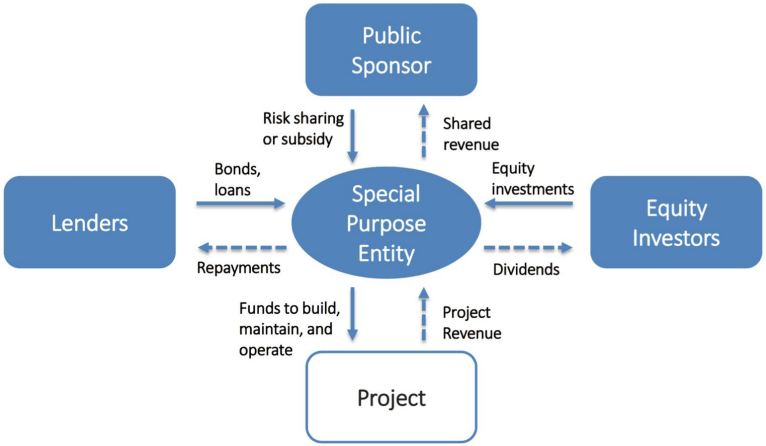
Private Sector Solution #7: Bundled EV/EVSE Financing

The "chicken vs. egg" debate is a common debate among policymakers, consumers, and investors: Which must scale first for the overall market to grow -- EVs or EVSEs?

Some investors see a simple answer: Both -- same location, with the same EV user base, at roughly the same time

A major global infrastructure investor stated that this "both" approach also addresses another limitation of investing in the EV market: Scale -- however, this has not been done yet to our knowledge (Source: IronOak Energy, Primary Research, 2016)

They noted that EVs could make up to 80% of the total investment -- as such, investments in EVSE alone would not achieve the size they need to dedicate the time to fully explore investment opportunities in the EV sector



(Source: US DOT Accelerating Alternative Fuel Vehicle and Infrastructure Deployment with Innovative Finance Mechanisms Workshop, 2016)

Public and private partnerships may be able to aggregate sufficient local EV and EVSE investment opportunity to attract the large project finance and infrastructure capital needed to add significant leverage to public dollars.

Private Sector Solution #8: Power Purchase Agreements

Higher capital costs (CapEx) for EVs compared to ICE vehicles is a barrier to greater adoption, despite the fact that long-term EV operating costs (OpEx) are lower

Power Purchase Agreements (PPAs) finances the combined CapEx and OpEx into one structured payment, which allows a business to (1) avoid the first cost burden of EV investment and (2) reduce their business-as-usual costs

The result is a financial product that allows EVs to be financed as a service, not as a piece of equipment

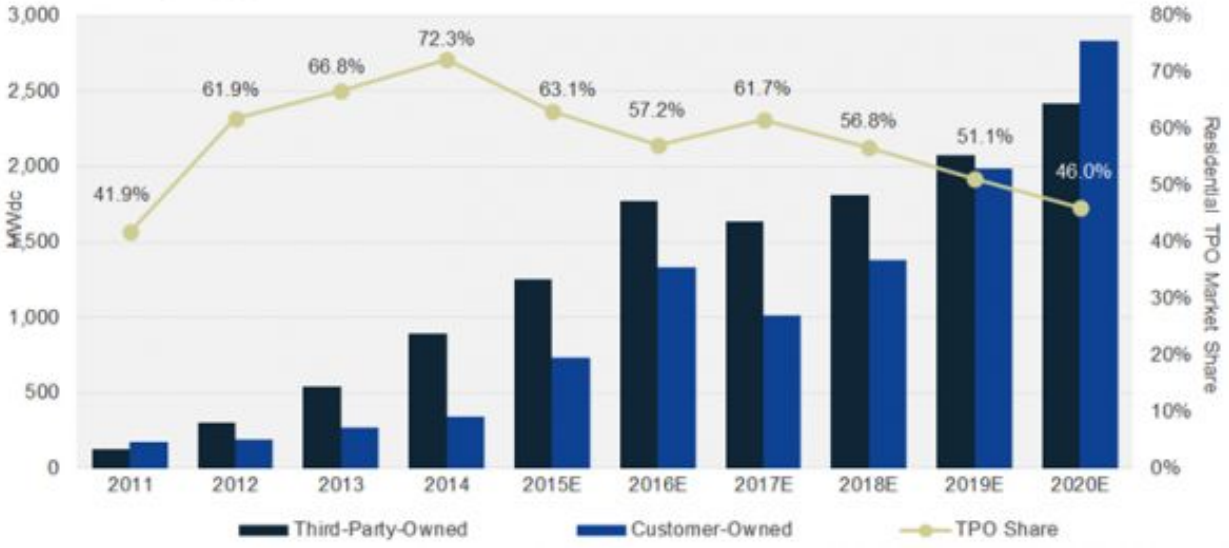
PPA model has been key to the US reaching 1 million solar installations in 2016 (Source: Greentech Media, 2016)

PPA-like structures could also help scale the EV market

Vision Fleet pursued a PPA-like business model treating "electric miles as a service." Although that model is operating in Indianapolis, Atlanta, and certain locations with the US GSA, the company had challenges and recently changed their name to EverCar and shifted their business model to focus on EVs in the car-sharing sector. The transition was mostly unrelated to the PPA model merits, and instead was caused by local politics and long public procurement processes.

Private Sector Solution #8: Power Purchase Agreements

FIGURE: Residential Third-Party Ownership Penetration and Installations by Ownership Type



(Source: Greentech Media, 2015)

This graph (beige line and dark blue bar) shows the dominance of third-party ownership of solar (or EV in this analogy) between 2012 and 2015. Note the shift to increasing customer ownership of solar (not a PPA) as the costs of solar continue to fall. The same phenomenon could be repeated with EVs as they approach first-cost neutrality around 2022.

Private Sector Financing Solutions	Pros	Cons
Loan/Lease Securitization	Attracts large amounts of capital into the EV space and helps finance EV manufacturers/financiers	Generates high transaction costs due to complicated financial structure and large investment scale
YieldCos	Bundles revenue generating assets into an investable product that shields investors from corporate solvency risk	Must be backed by stable cash flows -- may be challenging given EVSE business models; YieldCo model currently undergoing a market reset due to past structural flaws
Tax Credit Syndication	Allows developers with insufficient tax liabilities to fully utilize tax credits for EVSE development	Requires higher transaction costs to create a tax credit syndication structure -- limited by tax equity investor
Tax Credit Monetization	Allows EV purchasers to take advantage of the full tax credit at the point of purchase	Has limits to the degree to which lenders can and want to utilize tax credits
On-Bill Financing	Allows developers to amortize the cost of shared amenities like EVSE onto bills -- simple and proven approach	Forces shared cost model onto non-EV drivers
Fleet Management Company	Represents a large-scale opportunity to transition fleets through a single point of purchase/lease with companies that have a long-term economic view of vehicle investment	Remain skeptical about EVs and are conservative in their approach to investment
Bundled EV/EVSE Financing	Solves “chicken and egg” dilemma of financing EVs + EVSE simultaneously by creating investment opportunities of the necessary scale to attract larger investors	Complicated public-private partnerships and financial structures required to bundle EVs and EVSE assets with different return expectations
Power Purchase Agreements	Solves the first cost barrier for EVs by bundling CapEx and OpEx into a single contract	Requires organizations or consumers to get CapEx and OpEx out of their typical “silos” as distinct budget categories

Private Sector Financing Solutions	Angels	Venture Capital	Private Equity	Infra. Investors	Banks	Retail Investors	Corporate Finance	EV Consumer	EV Car Co.	EVSE Developer	Utilities
Loan/Lease Securitization			X	X	X	X	X		X		
YieldCos						X	X			X	
Tax Credit Syndication			X	X	X					X	
Tax Credit Monetization							X	X	X		
On-Bill Financing							X	X		X	X
Fleet Management Company							X		X		
Bundled EV/EVSE Financing		X	X	X	X		X		X	X	X
Power Purchase Agreements			X	X			X	X	X	X	X

Recommended Next Steps: Part 1

Study the 16 financial mechanisms discussed in this research to find the best fit for your projects. Cities, foundations, and other public capital providers should not pay full price for EV and EVSE rollouts. Instead, one or more of these financial structures mentioned in slides 31-54 could be helpful in reducing actual or perceived risks to help private investors piggyback on top of public dollars.

Focus on financial returns, not environmental or mission-related objectives. Although the latter are important and do factor into decision-making for some investors -- such as family offices, foundations, and certain high net worth individuals -- the majority of investors and the majority of their decisions rely on metrics such as return on investment, internal rate of return, and net present value.

Aggregate EV investment opportunities within the city in order to attract investors. Many investors are only attracted if they see the opportunity to invest large amounts of equity or debt in 1-2 large projects, or in many smaller projects that have similar attributes.

Recommended Next Steps: Part 2

Educate investors: The EV sector's growth and benefits are underestimated. The risks are overestimated. Solutions include live in-person or online events and organized stakeholder meetings supported by decision-making guidance documents.

Facilitate matchmaking between the broader investor world and cities pushing for EV expansion: Most investors are hesitant to spend time on general market discussions. They prefer instead to engage on discrete investment opportunities. Projects in the Smart City Challenge cities could be bundled into an investment presentation that can be discussed with a short list of investors to gauge interest, fit, and action items.

Focus on certain kinds of investors over others. While venture capital investments get the most media attention, they are not the most relevant for cities focused on growing EV activity in the near term. Instead, infrastructure equity investors and banks are more likely to play pivotal roles in bringing large amounts of private capital to match or exceed public sector resources.

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APPENDICES

ELECTRONIC SURVEY

Survey

Electronic survey administered via Google to 250+ potential respondents

Less than 6% completed responses

Questions were designed to elicit perceptions of the opportunities, risks, and challenges in financing EVs and EVSE

Many questions were structured on Likert scale, in which respondents specify their level of agreement or disagreement on a psychometric scale for a series of statements

Other questions were designed as multiple choice or open-ended to complement the core Likert scale questions

Financing Electric Vehicles (EVs) Survey

IronOak Energy Insights (http://insights.ironoak.energy), on behalf of the philanthropic arm of Vulcan (www.vulcan.com/areas-of-practice/philanthropy), is conducting market research on investment opportunities and challenges in the electric vehicle (EV) sector.

The goal is to catalyze greater private sector collaboration alongside public sector commitments to move the EV market forward faster.

Dozens of other investors, industry experts, and government innovators are also participating in this survey.

A summary of the results can be shared with survey participants.

Background:

IronOak Energy Insights --

IronOak, a clean energy research firm, has teams in the US, Europe, and Asia, and focuses on investment and strategy. Crafted by practitioners with PhD rigor, its market insights and action plans are provided via subscription services and bespoke analysis.

Vulcan Inc. --

Vulcan, based in Seattle, Washington is working to solve some of the biggest global issues. The programs we pursue are inspired by the ideas of our founder, philanthropist Paul G. Allen and tethered to a simple principle; we use data to inform our efforts and seek out opportunities that can make a positive impact—and share what we learn. Vulcan and its philanthropy programs support innovative approaches that can save endangered species, address climate change, improve ocean health, explore new frontiers, research how the human brain works and build sustainable communities. At Vulcan, we strive to answer big questions asked by our founder, and by the world. With a local focus and a global reach, our programs, projects and initiatives bring together industry leaders collaborating across disciplines to discover and develop smart, data-driven solutions and create inspiring experiences that help us tackle some of the world's toughest challenges.

IronOak ENERGY :: Insights

NEXT

Page 1 of 5

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Investor Interests in the EV Sector

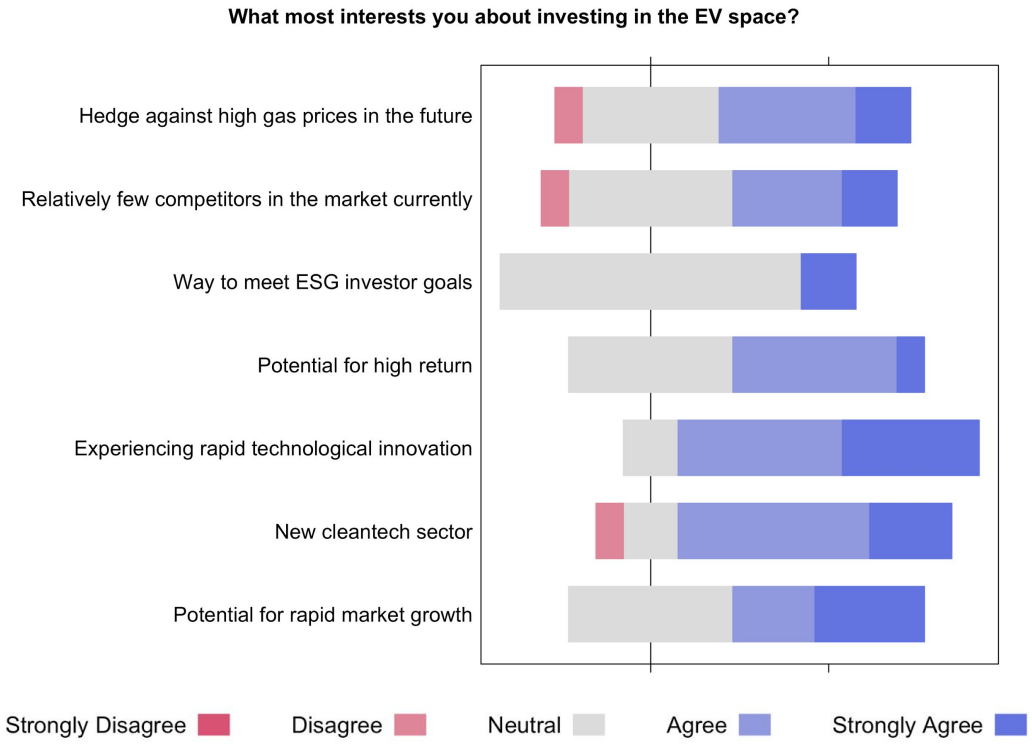
EVs support the growth of new entrant in the cleantech sector -- garnering interest from investors who may have become disinterested in the sector

Perception that the market holds promise but is not a “greenfield” investment opportunity

Belief in continued rapid growth and technological innovation

Some reservation about potential for investor returns -- however, investor base should be large given that ESG investor goals are not a key motivator

Still need for more investor education

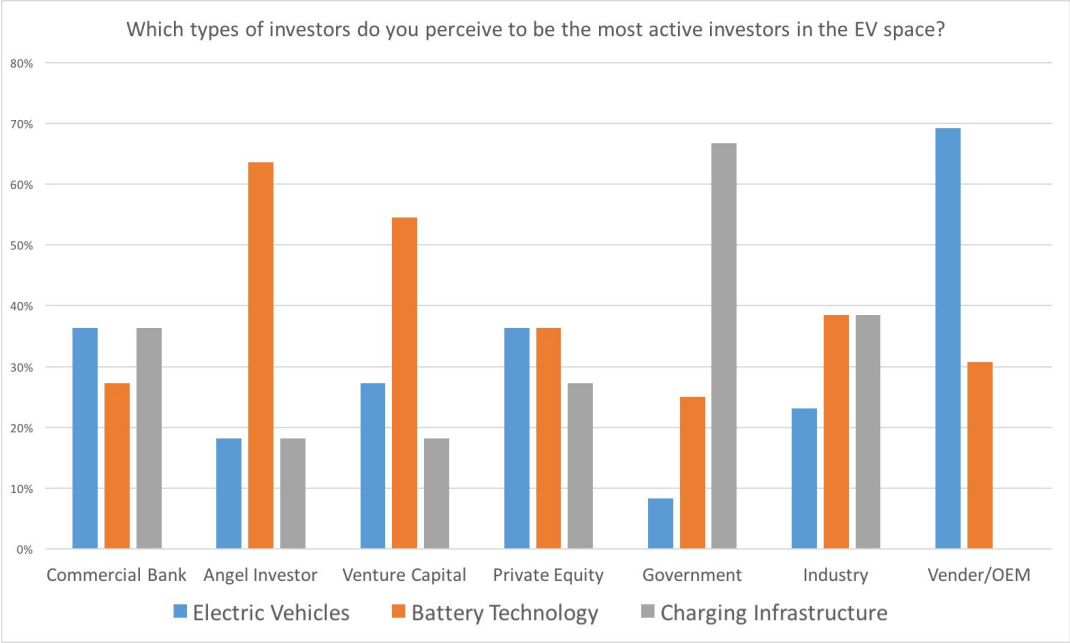


Investors Most Active in the EV Space

Electric Vehicles
Car manufacturers, some with backing from private equity firms and commercial banks

Battery Technology
Early stage investors such as angels and VCs mostly investing in battery technologies

Charging Infrastructure
Government and private companies



Barriers and Perceived Risks: EV Market

Challenges

Strongly held belief that EVs are still a very small niche -- low rate of adoption

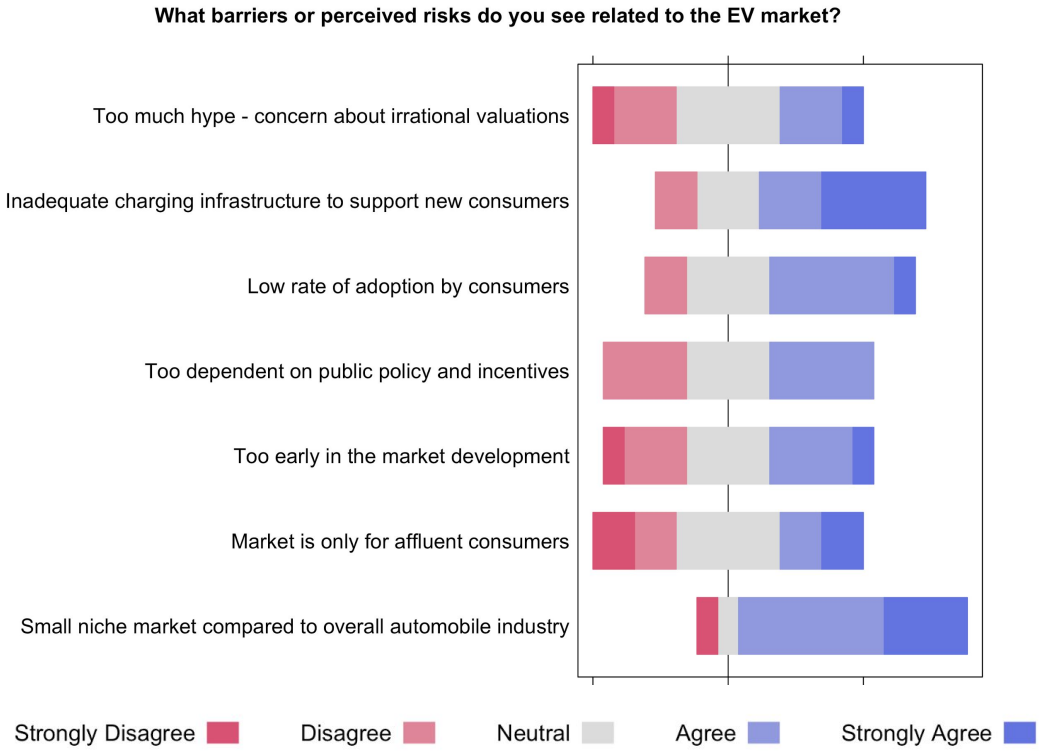
Perception of dependence on public policy and incentives

Inadequate infrastructure base of EVSE

Opportunities

EVs are increasingly accessible to middle income consumers

Sector not too early for investment



Barriers and Perceived Risks: EVs

Challenges

"Range anxiety" still a concern

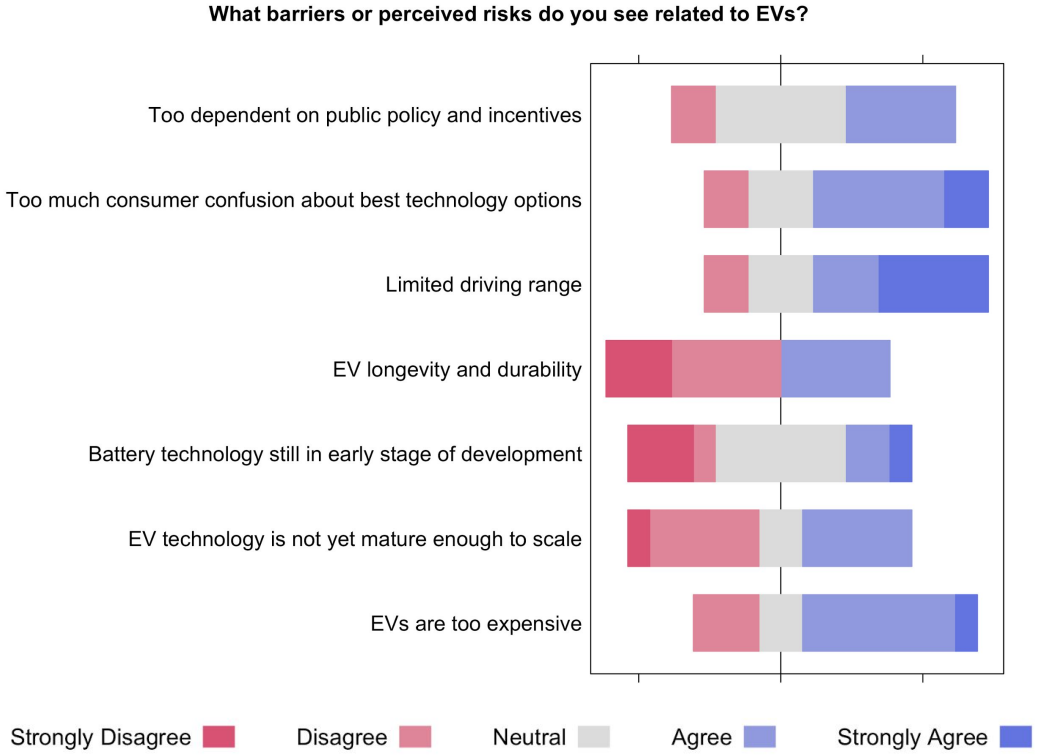
Longevity and durability of EVs

Customer confusion over EV options

Opportunities

Battery technology not perceived as very risky, but still in too early stage of development for some

EV purchase prices are still an impediment, but cheaper models are coming online



Barriers and Perceived Risks: EVSE

Challenges

Lack of adequate EVSE, and still very dependent on incentives/policy

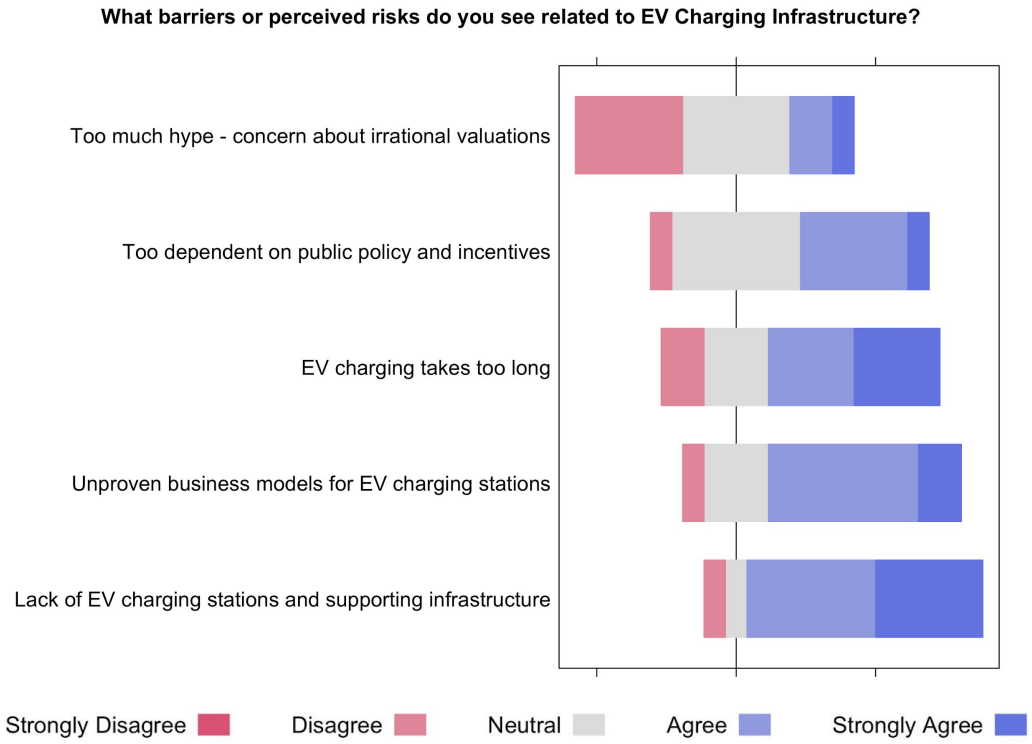
Unproven EVSE business model

Unwieldy charge time

Disagreement over ideal provider -- private sector vs. utilities vs government vs. combination

Opportunities

New model of fueling car -- EV charging stations should not follow the gas station model



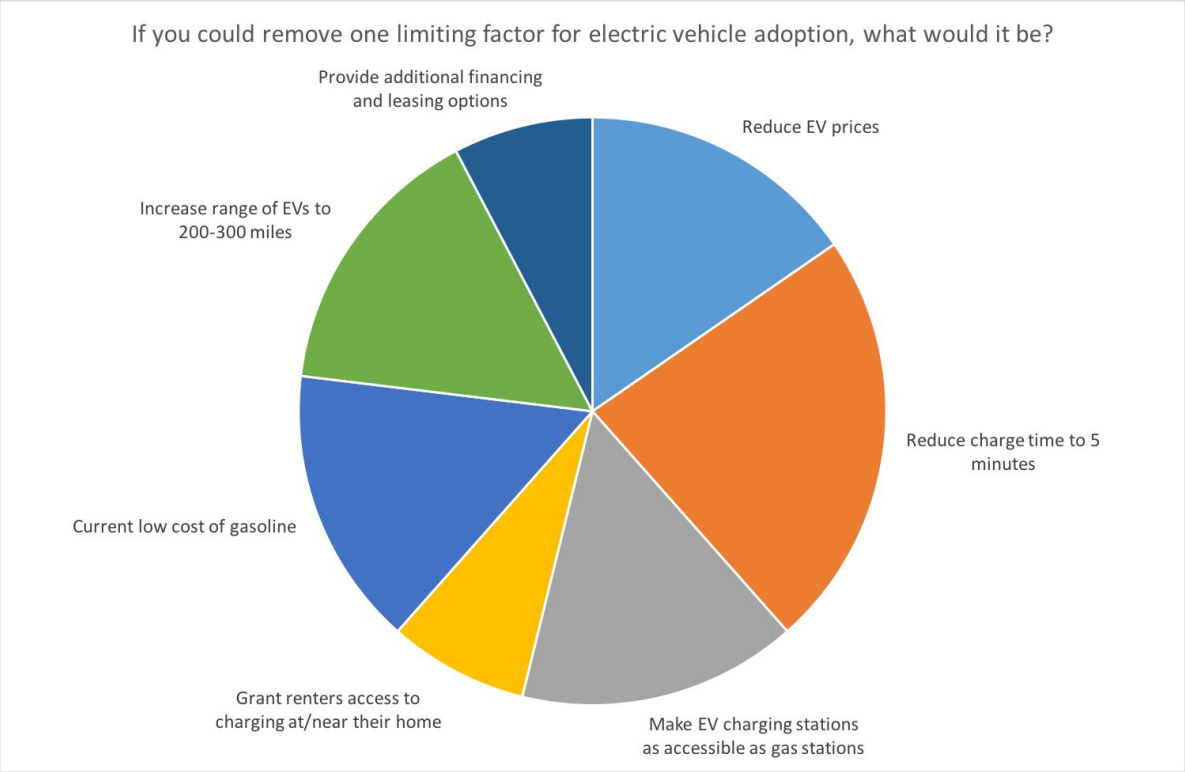
Removing Limiting Factors for EV adoption

Many issues need to be tackled simultaneously:

- Reducing EV prices
- Improving EV range
- Increasing access to EVSE

More financing/leasing options not a critical need

High personal adoption -- 90%+ of respondents expect to buy an EV within 5 years; confirms 2015 research that 80% of new-car buyers looked at an EV when in the market for a new car (Source: Kelley Blue Book, 2015)



Investor Targets in the EV Industry

Varied opinions on promising investment targets

Most Desirable

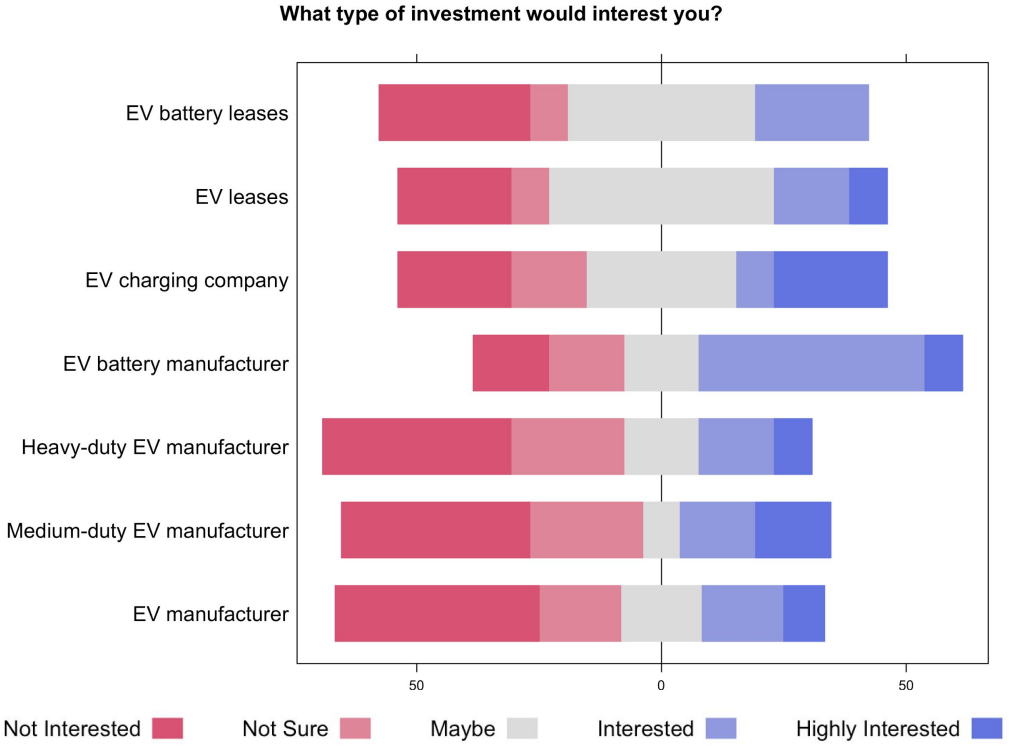
Battery manufacturers

EVSE is the greatest long-term opportunity

Infrastructure investment (project finance) in EVSE

Least Desirable

EV manufacturers, especially medium- and heavy-duty



ANGEL & VENTURE CAPITAL INVESTORS

Angel Investors: Profile, Focus, Motivation, Role in EV Sector

Target Investment Size	$10k to $500k
Target Investment Type	Very early stage company (e.g., young startup)
Timing for Investment to Reach Market	2 to 4 years
Risk Tolerance	Very high
Cost of Capital	30%
Example Investors	High net worth individuals or “angel groups”
Relevance to Columbus - LOW	Fund startups as part of an EV innovation ecosystem
Role in Growing EV Sector	See above

Venture Capital Investors: Profile, Focus, Motivation, Role in EV Sector

Target Investment Size	$1M to $80M
Target Investment Type	Early stage companies with proven traction
Timing for Investment to Reach Market	0 to 3 years
Risk Tolerance	High
Cost of Capital	30%
Example Investors	Kleiner Perkins, Sequoia, Vision Ridge, Khosla Ventures
Relevance to Columbus - MEDIUM	Fund startups as part of an EV innovation ecosystem; also VC-funded companies like ChargePoint can be helpful corporate partners
Role in Growing EV Sector	See above

Sample EVSE Companies with Angel and VC Funding

Company	Capital Raised	Company Focus	Sample Investors
Chargepoint	$149 million	National charging network	BMW | Kleiner Perkins | Siemens | Toyota
Volta	$7.5 million	Free EV charging (advertising revenue)	eBay | EPIC ventures
Greenlots	$7 million	Software EV charging aggregator	Tembisu | SBI Ven Capital
Evercharge	$1.4 million	EV charging for condos	1776 | Bolt
HEVO	$835,000	Wireless charging technology	Not disclosed

(Source: AngelList, 2016)

Angel and VC investors are actively searching for scalable charging solutions by experimenting with a variety of business models. Utilities and market-specific regulations are preventing dominance by a single solution.

INFRASTRUCTURE INVESTORS

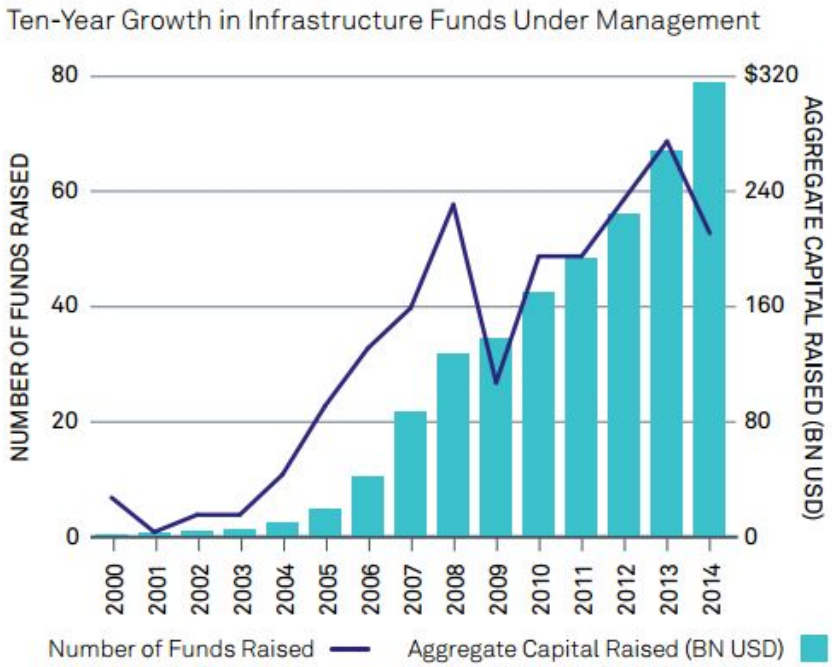
Infrastructure Investors (Equity): Profile, Focus, Motivation, Role in EV Sector

Target Investment Size	$10M to $200M
Target Investment Type	Fleets and infrastructure (sometimes companies)
Timing for Investment to Reach Market	0 to 18 months from [now]
Risk Tolerance	Low to moderate
Cost of Capital	5% to 17% (depends on risk profile)
Example Investors	JPMorgan, BlackRock, Macquarie Capital
Relevance to Columbus - HIGH	Finance for large fleets or EVSE networks with clear asset-level financial ROI
Role in Growing EV Sector	These investors require scale, which makes their role very important

Infrastructure Investors (Banks): Profile, Focus, Motivation, Role in EV Sector

Target Investment Size	$10M to $200M
Target Investment Type	Fleets and infrastructure (maybe mature companies)
Timing for Investment to Reach Market	0 to 18 months from [now]
Risk Tolerance	Low
Cost of Capital	3% to 9% (depends on risk profile)
Example Banks	Wells Fargo, Bank of America, US Bank
Relevance to Columbus - HIGH	Finance for large fleets or EVSE networks with clear asset-level financial ROI
Role in Growing EV Sector	These investors require scale, which makes their role very important

Infrastructure Investors (Equity): Increasing Amounts of Capital Allocated



Sources: BlackRock, February 2015; Preqin, *Infrastructure Investor* (data as of December 31, 2014). Aggregate capital raised (right scale) is cumulative, while number of funds raised (left scale) is presented on a year-by-year basis.

Equity for infrastructure investments has risen rapidly.

Moreover, the American Society of Civil Engineers estimates a need for $3.7T in the US by 2020 to upgrade infrastructure. (Source: American Society of Civil Engineers, 2016)

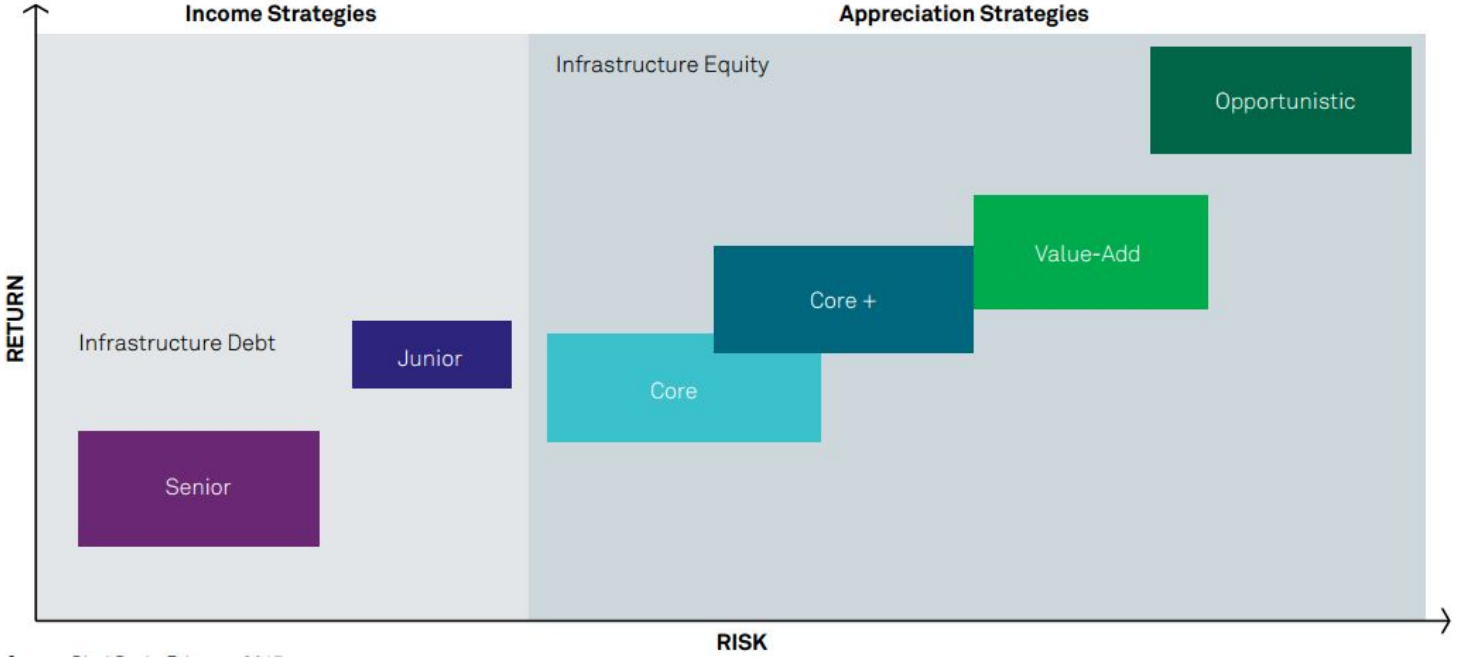
These investors are eager to find new sectors or geographies with opportunities. Many have great interest in energy right now. As such, EVs could be future sector of interest.

But most are not thinking about EVs because the market is too small and misunderstood.

(Source: BlackRock, 2015)

Infrastructure Investors (Equity): Risk-Return Profiles Vary, Part #1

Infrastructure Strategies and Comparative Risk and Return Positioning



(Source: BlackRock, 2015)

It is important to understand the nuances of infrastructure investors' tolerance of risk and financial return threshold. For projects, this goes from low risk senior debt to high risk (and higher return) options in the top right, where EVs probably fit.

Infrastructure Investors (Equity): Risk-Return Profiles Vary, Part #2

INFRASTRUCTURE STRATEGIES: KEY CHARACTERISTICS

	Investment Grade Debt	Junior Debt	Core Equity	Core + Equity	Value-Added Equity	Opportunistic Equity
Return Assumptions[1]	3.5-5.5%	5.5-9%	5-9%	8-12%	11-15%	15-17%
Key Risks	Operating Assumptions, Investment Structure	Market Risk, Operating Assumptions, Strategy Implementation	Operating Assumptions, Leverage Levels, Regulatory	Construction	Strategy Implementation	Market Risk, Political Risk and Currency Risk
Revenue Certainty (contracted)	Yes	No	Yes	Yes	No	In Some Cases
Already Revenue Generating?	N/A	N/A	Yes	No	In Some Cases	In Some Cases
Main Return Driver	Income	Income and Appreciation	Income	Income and Appreciation	Appreciation	Appreciation
GDP Sensitivity	Low	High	Low	Low	High	High
Greenfield or Brownfield	Both	Both	Brownfield	"Dark Green"	Both	Both
Development Risk	In Some Cases	In Some Cases	No	No	In Some Cases	In Some Cases
Return Driven by Exit?	No	No	No	No	Yes	Yes
Operating Complexity	Low	Low	Medium	Medium	High	Medium/High

Source: BlackRock, February 2015. **1** These ranges are BlackRock's return assumptions for infrastructure assets. BlackRock has arrived at these long-term, project-level return assumptions by applying the cost of capital and a discounted cash flow methodology, taking into account anticipated revenues and operational factors, to projects currently available in the market. The upper end of each targeted return range assumes the use of leverage and/or manager skill. The estimates are as of March 2015, may change as subsequent conditions vary and are presented for informational purposes only. No guarantee is made regarding the ability of investors to obtain returns within these ranges, either now or in the future.

The risks of EV infrastructure investments will be defined by variables such as these.

Cities might use public funds to limit actual or perceived risks in order to lower financial return needs for these kinds of project investors.

(Source: BlackRock, 2015)

GOVERNMENT & POLICY PROFESSIONALS

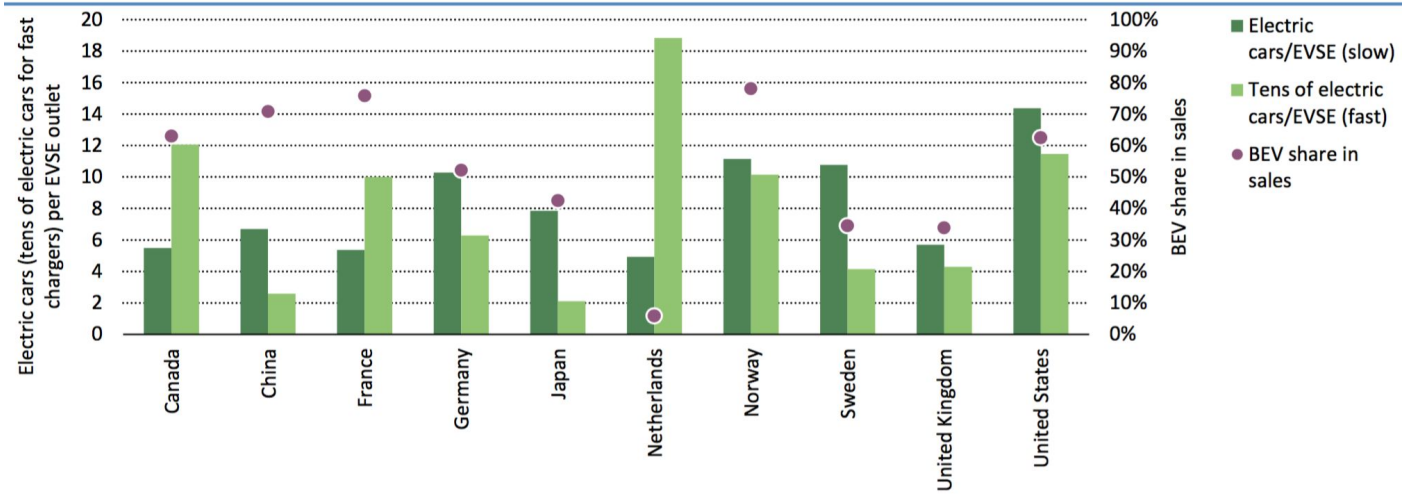
Government Professionals: Profile, Focus, Motivation, Role in EV Sector

Target Investment Size	Varies from home PACE loans to major bonds
Target Investment Type	Incentive programs, Bond issuances
Timing for Investment to Reach Market	0 to 18 months from [now]
Risk Tolerance	Low
Costs of Capital	0 to 4%
Example Innovators	State of Colorado, City of San Francisco
Relevance to Columbus	There are lessons to learn from other cities that have been a part of EV public-private partnerships
Role in Growing EV Sector - ESSENTIAL	Government procurement processes, fleet management, code requirements, and consumer education provide key points of influence

FINANCING EV CHARGING INFRASTRUCTURE

U.S. EVSE Infrastructure: It Lags Globally

Figure 13 • Electric cars/EVSE stock ratio for slow and fast publicly available chargers and share of BEVs in total electric car stock, 2015

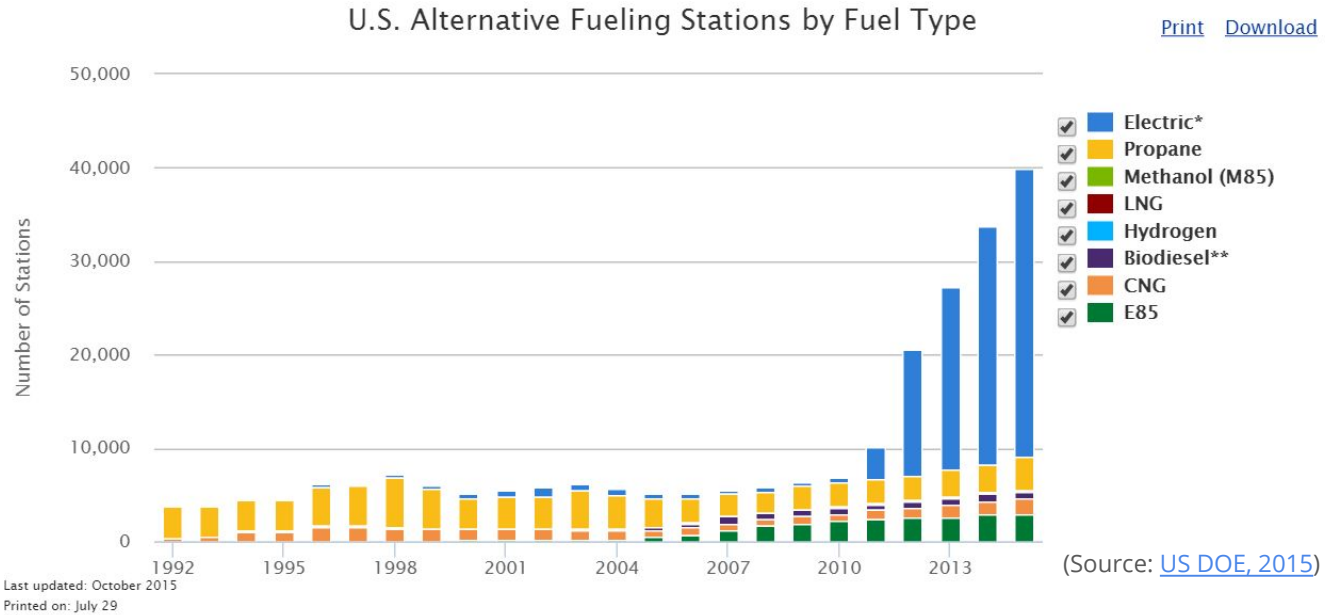


(Source: International Energy Agency, 2016)

BEVs comprise more than 60% of US EV sales, indicating the need for expansion of EVSE infrastructure.

US ratio of EV / EVSE is above 10 for both slow and fast charging systems, which is higher than nearly all other countries with significant EV stocks.

U.S. EVSE Infrastructure: It's Getting Better



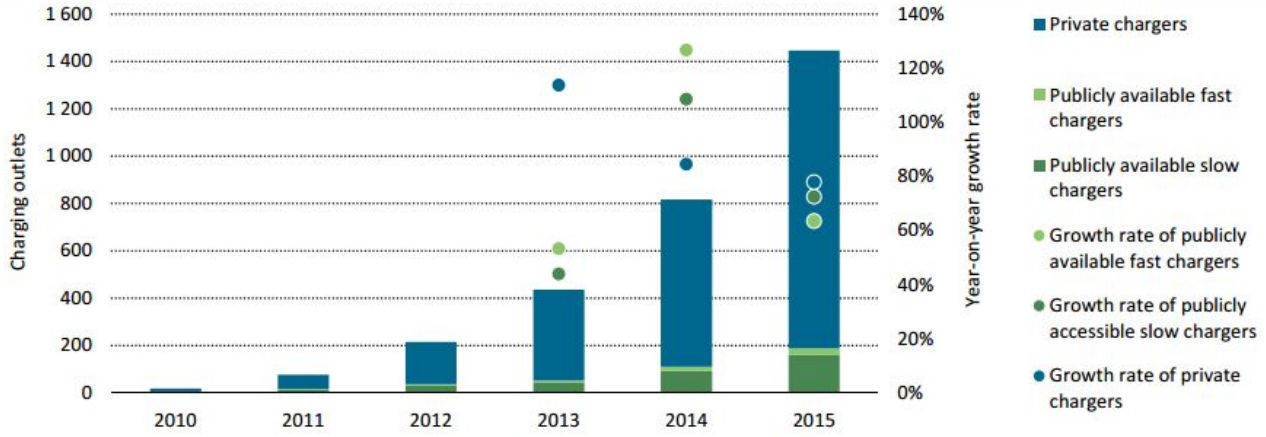
(Source: US DOE, 2015)

US has seen 4x growth in EVSE between 2011 and 2015.

The July 2016 US federal loan guarantee program for EVSE is likely to increase this growth trajectory.

EVSE Penetration: Perceived or Actual Risks?

Figure 11 • Global EVSE outlets, 2010-15



Note: Private chargers are estimated assuming that each EV is coupled with a private charger.

(Source: International Energy Agency, 2016)

Investors care about actual and perceived risks.

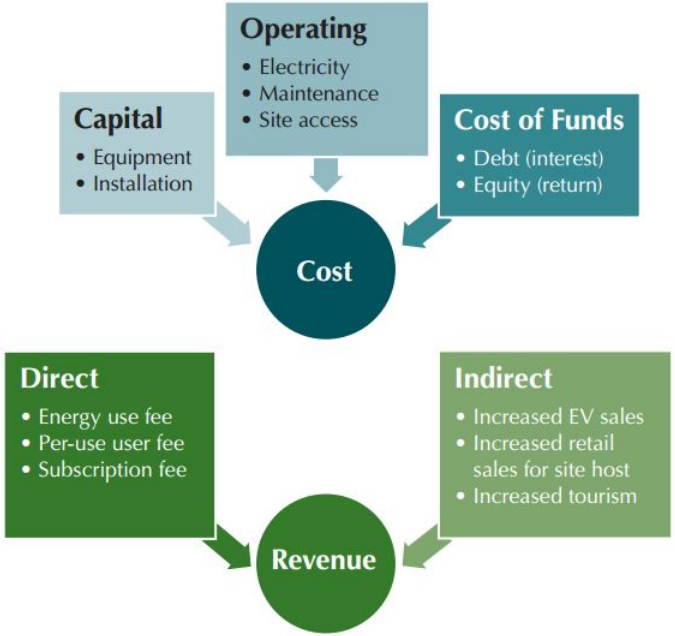
The vast majority of chargers are private.

If off-peak chargers become the norm, and if most fleets are privately charged, actual range limitations may be a moot point.

Regardless of whether those conditions are true, range anxiety is about perceived limitations. Perception is reality.

Financing EVSE: Tenuous ROI

FIGURE 23: Cost and Revenue Components of EV Charging Business Models

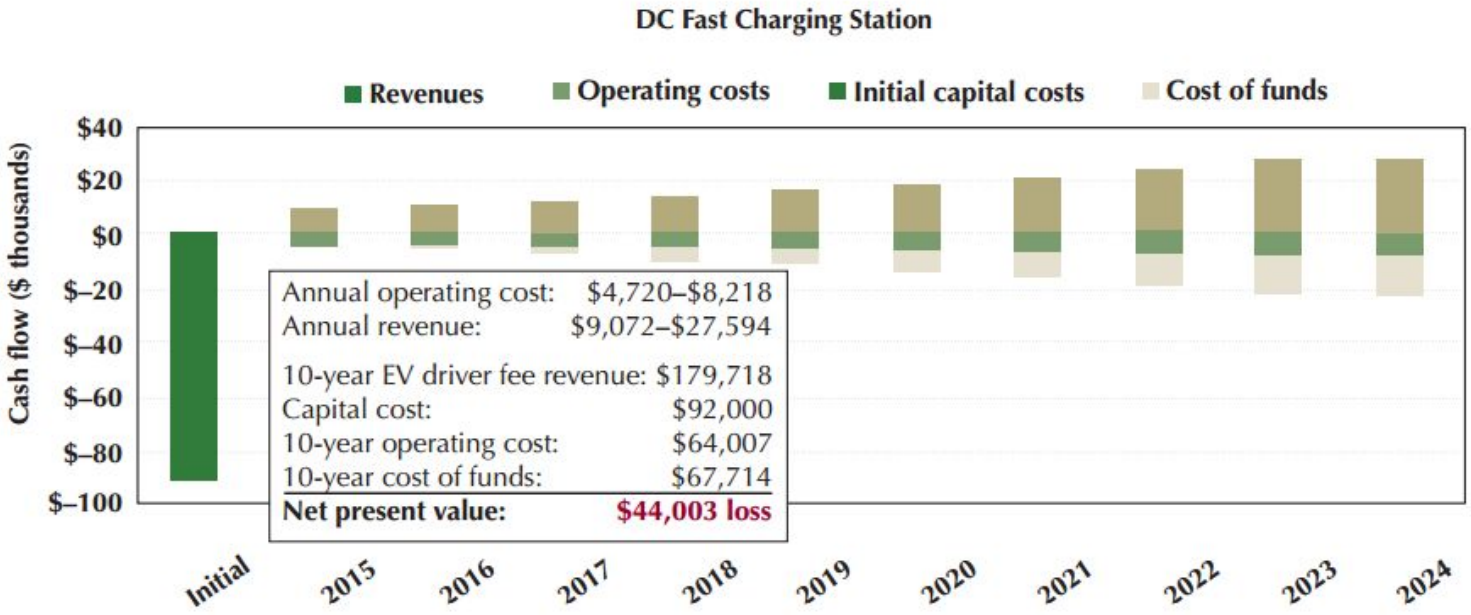


EVSE are often not financially attractive with market-rate capital and operating expenses, and direct revenues.

However, a positive ROI is possible with some combination of government subsidies, more debt, lower costs of capital, higher electricity costs, low site access costs, and indirect revenues, such as increased retail sales at the EVSE location.

(Source: Center for Energy and Climate Solution, 2015)

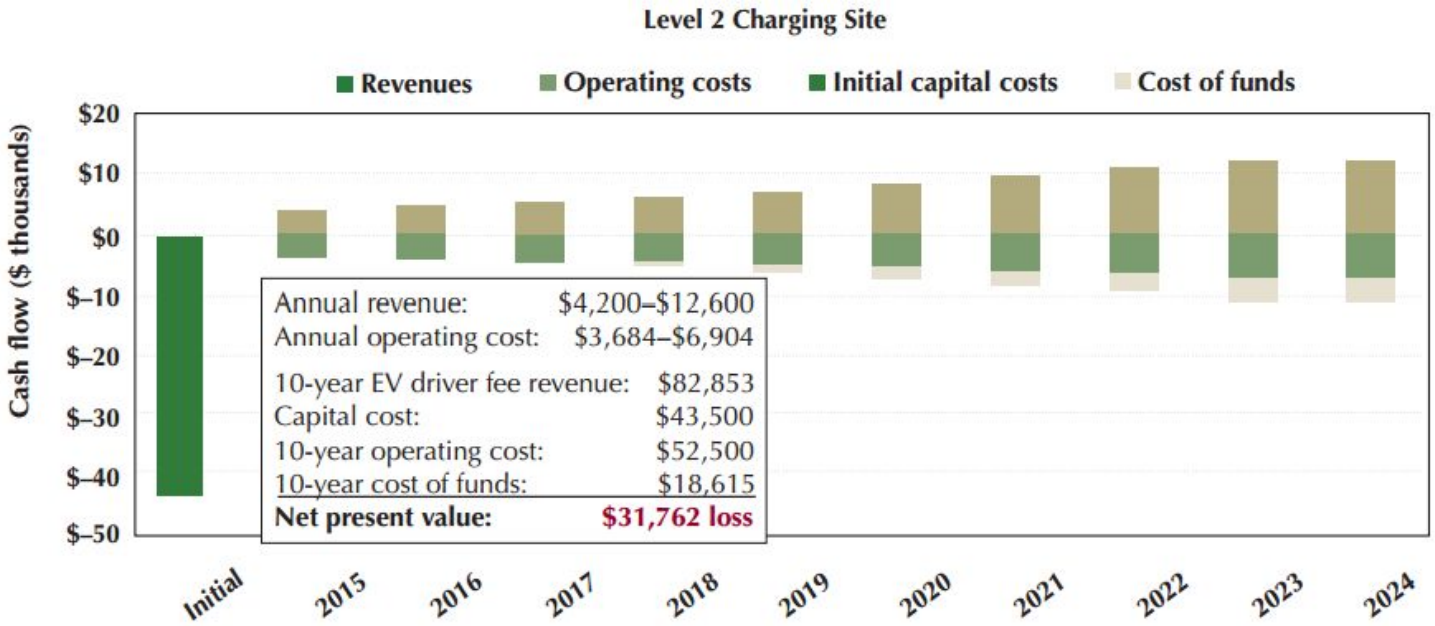
Financing EVSE: DC Fast Charging - Negative NPV



In most cases, DC fast chargers require indirect benefits or cost subsidies to justify the ROI.

(Source: Center for Energy and Climate Solution, 2015)

Financing EVSE: Level 2 Charging - Negative NPV

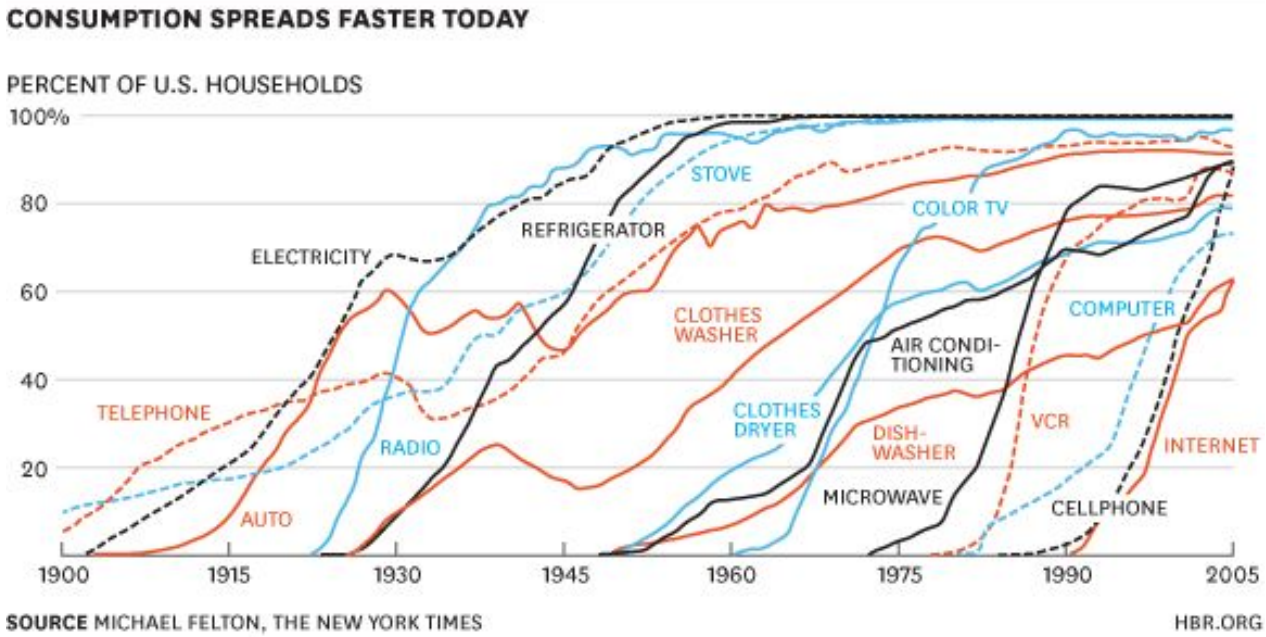


In most cases, level 2 chargers require indirect benefits or cost subsidies to justify the ROI.

(Source: Center for Energy and Climate Solution, 2015)

EV MARKET GRAPHS:
STATUS, GROWTH, TECHNOLOGY, OPPORTUNITIES

How Fast Can EVs Grow? Angel and VCs Care



It seems difficult for many investors to believe that EVs will represent a substantial share of the vehicle market in the near term.

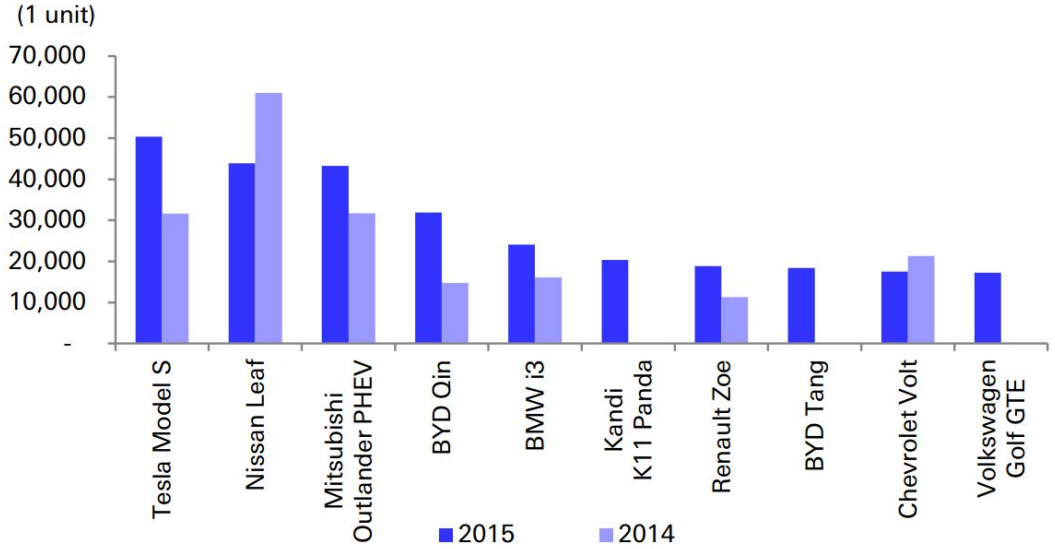
However, consumer adoption of other household electronics and products occurred relatively fast.

Importantly, the slope of this adoption curve is getting steeper with more recent innovations.

(Source: New York Times, 2008)

EV Market Share by Car Manufacturer (2015 vs. 2014)

Figure 30: Worldwide EV sales by model



Source: Deutsche Bank, InsideEVs, industry data

The media makes it seem like Tesla is the only serious EV manufacturer.

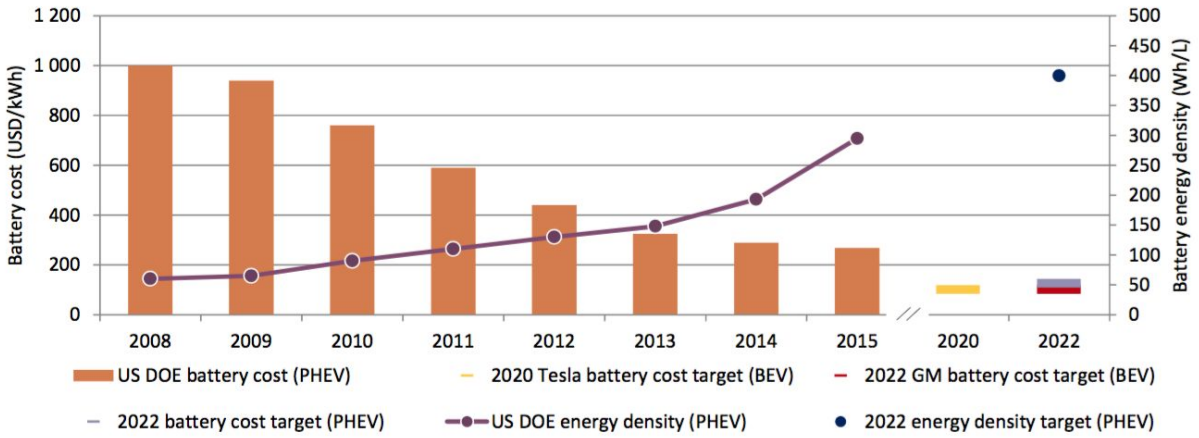
However, that is not true.

Moreover, many leading EV OEMS are not in the US.

Investors need an understanding of all market players, not just the obvious ones.

Battery Technology Costs & Energy Density

Figure 2 • Evolution of battery energy density and cost



Notes: USD/kWh = United States dollars per kilowatt-hour; Wh/L = watt-hours per litre. PHEV battery cost and energy density data shown here are based on an observed industry-wide trend, include useful energy only, refer to battery packs and suppose an annual battery production of 100 000 units for each manufacturer.

Sources: US DOE (2015 and 2016) for PHEV battery cost and energy density estimates; EV Obsession (2015); and HybridCARS (2015).

Battery technology costs have decreased by nearly 75% since 2008.

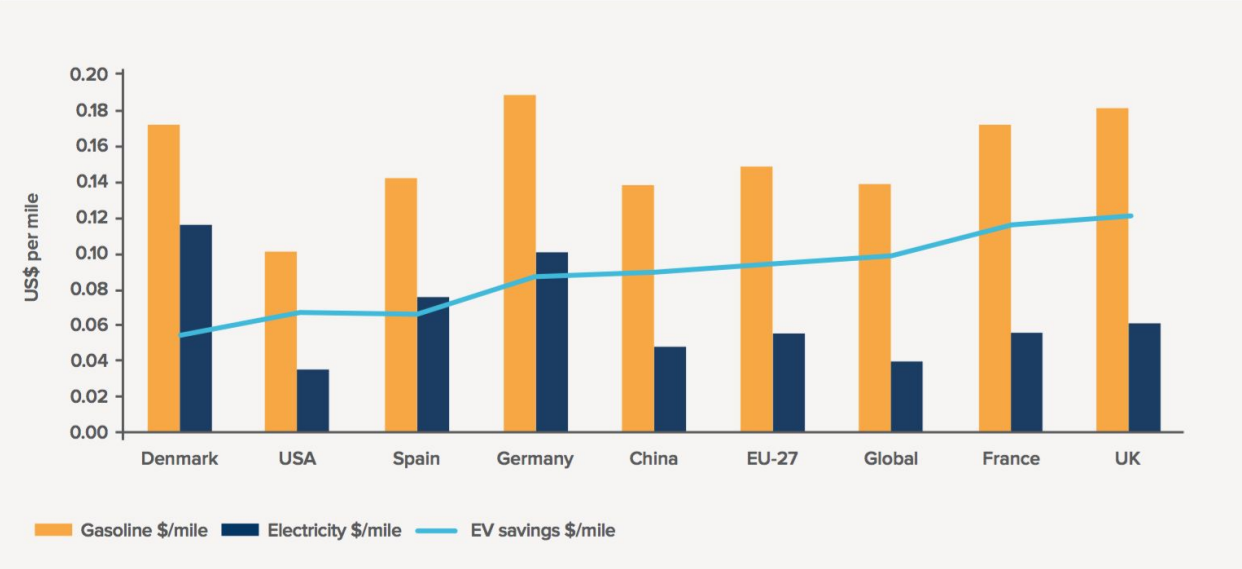
Battery energy density is just as important a factor, and have nearly doubled since 2008.

The combination of reducing battery costs and increasing energy density are driving down EV costs, making them more competitive with ICE vehicles on a purchase price basis.

(Source: International Energy Agency, 2016)

EV Savings/Mile Significant Even With Low Gas Prices

FIGURE 3: AVERAGE FUEL COSTS AND EV COST SAVINGS PER MILE

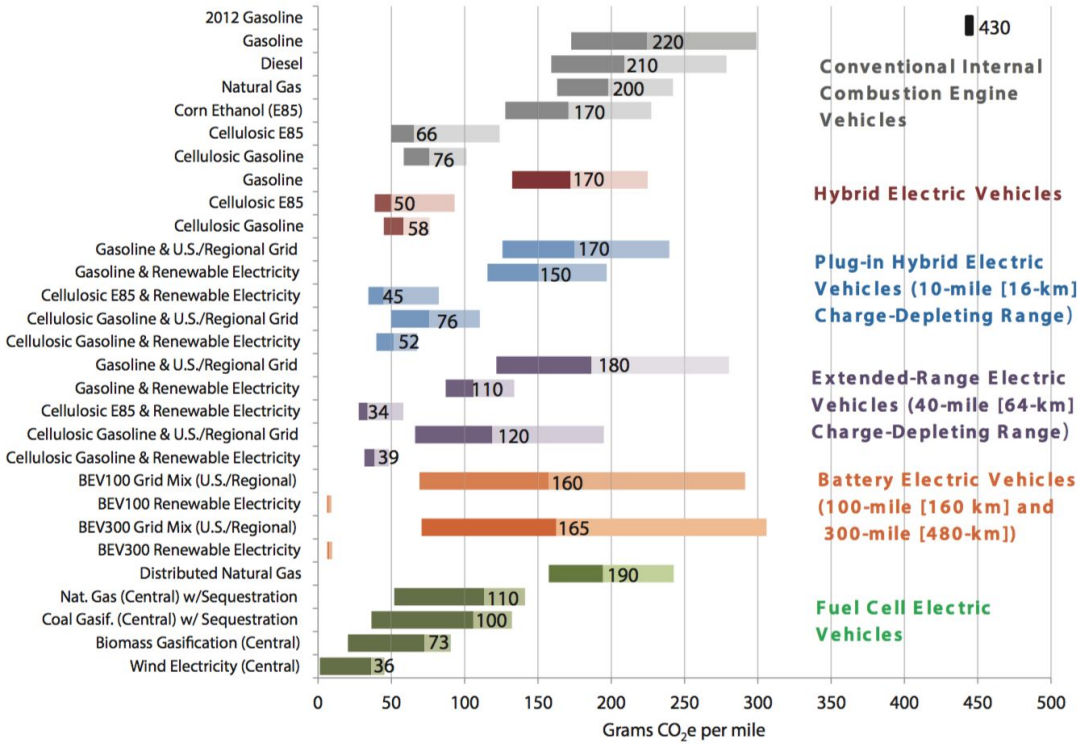


EV savings per mile are significant across many countries, even those with high electricity prices compared to the US.

Low gas prices in the US undercut the potential savings from EVs, but this is partially offset by the comparatively low electricity prices.

(Source: Rocky Mountain Institute, 2016)

EV Carbon Benefits Depend on Grid Decarbonization



From a climate perspective, BEVs provide the largest potential carbon reduction compared to conventional ICE cars.

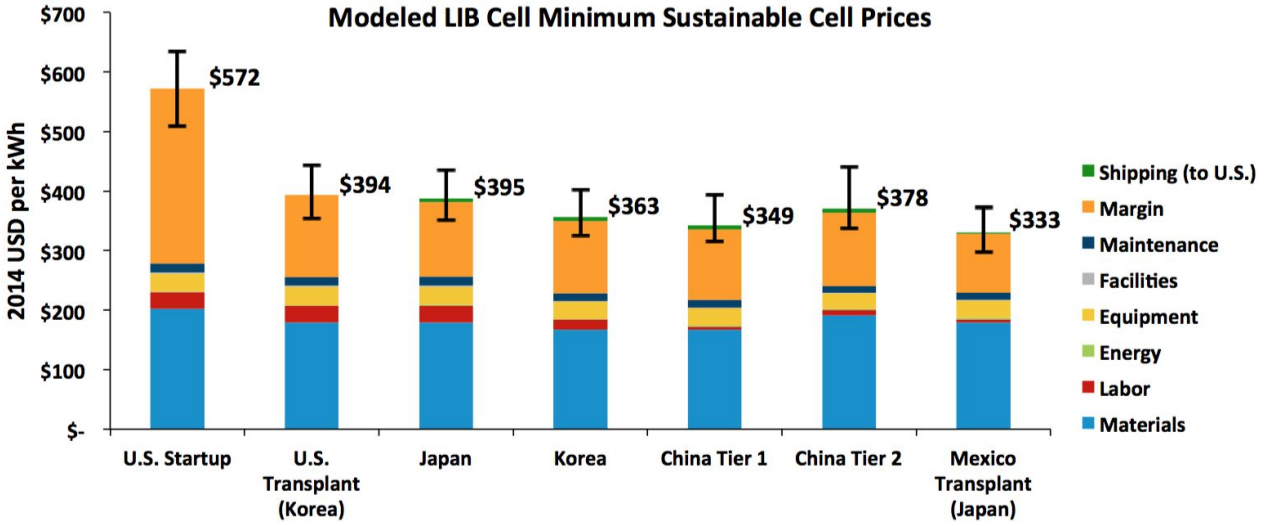
Actual carbon benefits depend on the carbon intensity of the electric grid.

With renewable electricity, BEVs would approach carbon neutrality.

With the current electric grid, PHEVs may actually have a larger carbon reduction impact than BEVs.

(Source: MIT, 2015)

Global Battery Supply Chain Will Affect EV Costs



Forecasted annual growth rates in automotive Lithium Ion Batteries (LIB) demand range from 22% to 41% through 2020.

LIB manufacturing capacity is primarily located in China, Japan, and Korea, which constitute 85% of global LIB production capacity.

Current LIB manufacturing capacity far exceeds production - utilization was 22% in 2014. Could be ramped up to meet new demand.

Mexico's low cost of labor and low cost of capital could sustain the most competitive prices on the global market over the long-term.

Investors will need to pay attention to the global LIB supply chain.

(Source: NREL, 2015)

EV Market Adoption: Aggregate vs. Penetration

Table 3 • Electric car stock targets to 2020 based on country commitments

Countries with announced targets to 2020 or later	2015 EV stock (thousand vehicles)	2020 EV stock target (million vehicles)	EV share of all cars sold between 2016 and 2020	EV share in the total 2020 stock	Source
Austria	5.3	0.2	13%	4%	BMVIT, 2012
China*	312.3	4.6	6%	3%	State Council, 2012
Denmark	8.1	0.2	23%	9%	ICCT, 2011
France	54.3	2.0	20%	6%	MEEM, 2011
Germany	49.2	1.0	6%	2%	IA-HEV, 2015
India	6.0	0.3	2%	1%	LBNL, 2014
Ireland	2.0	0.1	8%	3%	SEAI, 2014
Japan	126.4	1.0	4%	2%	METI, 2016
Netherlands**	87.5	0.3	10%	4%	EVI, 2016a
Portugal	2.0	0.2	22%	5%	IA-HEV, 2015
South Korea	4.3	0.2	4%	1%	MOTIE, 2015
Spain	6.0	0.2	3%	1%	MIET, 2015
United Kingdom	49.7	1.6	14%	5%	EC, 2013 and CCC, 2013
United States***	101.0	1.2	6%	2%	IA-HEV, 2015
Total of all markets listed above	814.1	12.9	7%	3%	

Investors care about EV market maturity in terms of volume (aggregate numbers) as well as market share (penetration).

One or both of these numbers reflect where the country or city is on the adoption curve.

This positioning relates to risk tolerance, investment hold periods, and financial return potential.

(Source: International Energy Agency, 2016)

EV Government Incentives Vary Greatly by Country

Table 1 • Summary of policy support mechanisms for EV uptake in place in selected countries in 2015

	EV purchase incentives				EV use and circulation incentives				Waivers on access restrictions			Tailpipe emissions standards		
	Rebates at registration/sale	Sales tax exemptions (excl. VAT)	VAT exemptions	Tax credits	Circulation tax exemptions	Waivers on fees (e.g. tolls, parking, ferries)	Electricity supply reductions/exemptions	Tax credits (company cars)	Access to bus lanes	Access to HOV lanes	Access to restricted traffic zones*	Fuel economy standards/regulations including elements	Road vehicles tailpipe pollutant emissions standards	Market share of electric cars in 2015
Canada													Tier 2	0.4%
China													China 5	1.0%
Denmark													Euro 6	2.2%
France													Euro 6	1.2%
Germany													Euro 6	0.7%
India													Bharat 3	0.1%
Italy													Euro 6	0.1%
Japan													JPN 2009	0.6%
Netherlands													Euro 6	9.7%
Norway													Euro 6	23.3%
Portugal													Euro 6	0.7%
South Korea													Kor 3	0.2%
Spain													Euro 6	0.2%
Sweden													Euro 6	2.4%
United Kingdom													Euro 6	1.0%
United States													Tier 2	0.7%

Legend:	
	No policy
	Targeted policy **
	Widespread policy***
	Nationwide policy
	General fuel economy standard, indirectly favouring EV deployment
Euro 6	Pollutant emissions standard in place in 2015

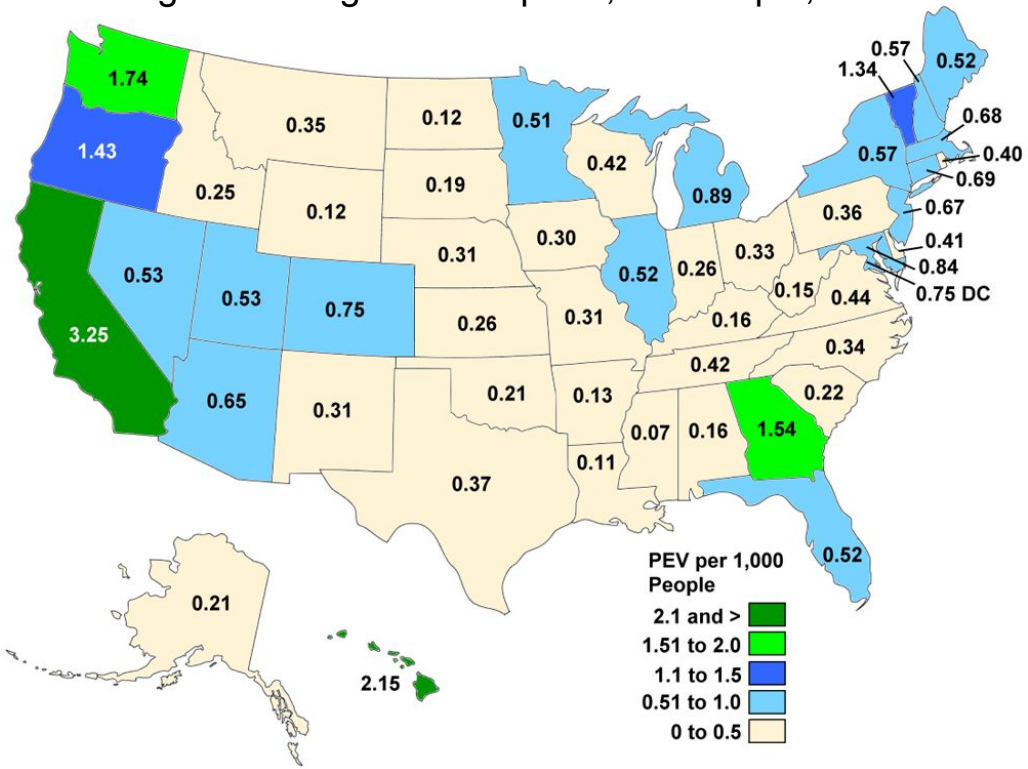
Investors will use this information to target near-term geographies for investment.

However, most investors do not like policy dependency and uncertainty.

(Source: International Energy Agency, 2016)

Local Policy: Role in Adoption Variance

Plug-In EV Registrations per 1,000 People, 2014



State and local government policy innovation plays a key role in determining EV market growth. This data from 2014 is representative of the same situation today.

EV penetration is very low; Hence, the upside over time could be very large, depending on an investor's time horizon.

(Source: US DOE, 2015)

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